LIFE CYCLE ASSESSMENT APPLIED TO 95 REPRESENTATIVE U.S. FARMS

A Thesis

by

CHRISTOPHER T. RUTLAND

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

August 2011

Major Subject: Agricultural Economics

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Approved by:

Chair of Committee,	James W. Richardson
Committee Members,	Joe Outlaw
	Clair J. Nixon
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ABSTRACT

Life Cycle Assessment Applied to 95 Representative U.S. Farms.

(August 2011)

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Chair of Advisory Committee: Dr. James W. Richardson

Since World War II, concern for the environmental impacts of human activities has grown. Agriculture plays a significant role in several impact categories including global warming. Governments, including the U.S., have recently begun or are considering the regulation of greenhouse gas (GHG) emission to mitigate the global warming effect. Because agriculture accounts for a large portion of anthropogenic greenhouse gas emissions, it is necessary to establish a baseline measure of the GHG emission of U.S. agriculture at the farm level. The objective of this research is to estimate the GHG emission levels for multicrop farms in the U.S. and identify the major sources of GHG emissions in their supply chains.

To accomplish the objective, a partial life cycle assessment (LCA) methodology is used to establish a GHG baseline for the representative farms. LCA as defined by the International Organization for Standardization (ISO) includes four phases: goal and scope definition, inventory, impact assessment, and interpretation. It is a holistic approach that catalogues environmental impacts of all relevant processes at all stages of

production, from raw material extraction to disposal. However, this study only catalogues impacts up to the farm gate. Partial LCAs are common in agriculture.

Emissions of three GHGs, CO_2, CH_4, and N_2O, are inventoried for 95 U.S. farms. The results are characterized using their 100-year global warming potentials into CO_2 equivalents. The CO_2 equivalents are then normalized over four functional units: enterprises, acres or head, harvest units, and pounds of production.

The variation of GHG intensity between crops and farms is very large. However, it is clear that GHG intensity is affected by three characteristics: location, size, and irrigation practice. Crops grown in their associated regions tend to be more GHG efficient than those grown outside their associated regions. Also, crops grown on large farms tend to be more GHG efficient than the same crop grown on a small farm in the same area. Lastly, with the exceptions of cotton and soybeans, irrigated crops tend to be more GHG intensive than non-irrigated crops. These results combine to suggest that there may be a correlation between production efficiency and carbon efficiency.

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CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

Background

Since World War II and the detonation of the first atomic bomb, global concern for the impact of human activities on the environment has grown (Stoll 2007). A wide variety of issues has been raised, including global warming, ozone depletion, eutrophication, desertification, and water pollution. As international agreements have been signed, the momentum of the global environmental movement has radically altered the landscape of the global economy. The publishing of the Intergovernmental Panel on Climate Change's first report in 1990 (Houghton, Jenkins, and Epraums 1990) marked a major milestone for the environmental movement. It increased awareness of global climate change due to human activity, as well as the general environmental impacts of human activity and their associated economic costs. Since 1990, multilateral treaties over a wide range of environmental issues have been negotiated, such as the Kyoto Protocol and the United Nations Convention to Combat Desertification.

Furthermore, the last 60 years have seen multiple policy changes in the United States. The U.S. Environmental Protection Agency regulates water pollution and use (Clean Water Act 1972), air pollution (Clean Air Act 1970), land pollution (Resource Conservation and Recovery Act 1976), pesticide use (Federal Insecticide, Fungicide, and Rodenticide Act 1996). In 2007, *Massachusetts vs. EPA* confirmed the authority of the

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This thesis follows the style of the *American Journal of Agricultural Economics*.

EPA to regulate greenhouse gas emissions in the United States, in addition to its regulation of other human activity-induced emissions.

Research has shown that the agriculture industry's contribution to environmental problems is significant. For instance, high soil phosphorus levels, which primarily depend on the use of agricultural fertilizers, were found in 53% of the soils sampled in a nationwide survey conducted by Fixen and Roberts (2002). Freshwater consumption in the Western United States is 83% agriculture-related (Schaible 1997). Also, the IPCC reported that agriculture accounted for 13.5% of total carbon dioxide equivalent emissions in 2004 (Pachauri and Reisinger 2007). U.S. lawmakers have considered several options for further regulating the environmental impacts of industry, including additional taxes and cap-and-trade (Adams 2009). Agricultural operations, however, are somewhat flexible and can potentially alter their carbon balance by using less C-intensive management practices such as low-till, no-till, and reducing fossil fuel use by altering irrigation and fertilization practices (Lal 2004). Because polluting and not polluting as described by Leontief (1970) have associated costs and benefits to society, their analysis is important in any policy consideration.

Carbon dioxide and other greenhouse gas (GHG) emissions are particularly relevant because many researchers believe that human-induced CO_2 emissions are contributing to the recent rise in global average temperature. Some researchers assert that this could cause climatic and geological anomalies including droughts, flooding, changes in river drainage systems, more frequent hurricanes, and more frequent wildfires (Büntgen et al. 2011; Gedney et al. 2006; Trenberth 2011; Bender et al. 2010; Carcaillet, Bergeron, and Richard 2001). These anomalies are likely to affect agricultural species composition, yields, and water supplies (McCarl 2000; Seo, McCarl, and Mendelsohn 2010; Guereña et al. 2001). It is therefore vital to understand U.S. agriculture's role in greenhouse gas emissions, so policy makers and producers can make more informed decisions.

Problem statement

Because of agriculture's significant role in greenhouse gas emissions, it is necessary to establish a baseline measure of these emissions at the farm level. Agricultural operations also have the potential to reduce GHG emissions as well as become sinks (McCarl 2000). Extensive research has been conducted on the environmental implications of many single- and a few multi-cropping systems, mostly abroad, but the literature is limited in environmental assessments of U.S. farms as multi-enterprise firms. Furthermore, most of the assessments done for U.S. farms rely heavily on average input data from large, pre-made databases. Before any new and possibly stricter regulations are enacted, an assessment of GHG emissions and their economic implications needs to be performed for U.S. farm products including cotton, soybeans, wheat, rice, corn, milk, and beef.

Objective

The objective of this research is to estimate the GHG emission levels for multicrop farms in the U.S. and identify the major sources of GHG emissions in their supply chains. The farming operations analyzed will be the set of representative farms maintained by the Agricultural and Food Policy Center (AFPC) at Texas A&M

University. The results of the analysis can then be used in conjunction with the existing Farm Level Income and Policy Simulation Model (FILPSIM) to simulate the interaction between agricultural policy and environmental policy, income, and environmental impacts (Richardson and Nixon 1986).

A partial life cycle assessment (LCA) methodology will be used to establish a GHG baseline for the representative farms. LCA as defined by the International Organization for Standardization (ISO) includes four phases: goal and scope definition, inventory, impact assessment, and interpretation (2006a). The goal and scope definition phase is where the researcher defines the objective of the LCA, as well as the functional unit(s) and the system boundaries. The objective for this analysis has already been stated. However, the system boundaries are defined as follows. If the agricultural production process is thought of as a series of vertical steps, the lower bound of the system is raw material extraction for fertilizers, chemicals, electricity, and fuels. With one exception, the upper bound of the system is the farm gate, i.e., this study includes impacts up to the time when the product leaves the farm. The exception is made for dairies. Because milk hauling is such a large part of the milk supply chain, GHG emissions from hauling milk off the farm are included for these farms. Four functional units will be included in this analysis: emissions per crop or enterprise, per acre, per unit of commodity harvested (bushel, pound, ton, or hundredweight, depending on the commodity), and per pound of commodity harvested. All functional units are emissions in a period of one year. Including four functional units will improve the robustness of the results, as different functional units can lead to different interpretations and conclusions (Haas, Wetterich, and Geier 2000).

The inventory phase is when emissions from the relevant processes are catalogued. This analysis includes CO_2, CH_4, and N_2O emissions from raw mineral extraction for inputs, manufacturing and refining inputs, transporting inputs and using the inputs. These are estimated using emission factors in the general form, emission per unit consumed. These factors are derived from either the IPCC, the U.S. EPA, or the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model (Eggleston et al. 2006; 2011; Wang 2008). GHG emissions from the other on-farm sources, livestock processes (manure handling and enteric fermentation), direct and indirect GHG emissions from soils, as well as carbon sequestration are estimated using emission factors from the IPCC and the EPA (Eggleston et al. 2006; 2011).

The next phase is the impact assessment. Impact assessment is where the inventory results are assigned to appropriate impact categories, characterized and normalized over the functional unit. The sole impact category of this study is climate change. All inventory results are therefore assigned to the climate change category. The results will be characterized using the IPCC 100-year model (Solomon et al. 2007). This model uses the infrared radiative forcing of different greenhouse gases to calculate their individual 100-year global warming potential (GWP) relative to CO_2. These CO_2 equivalents will then be normalized over the four functional units: total CO_2 equivalent emissions per crop, CO_2 equivalent emissions per planted acre, and CO_2 equivalent emissions per harvest unit (bushel, pound, ton, etc.), and CO_2 equivalent emissions per pound of crop harvested. The results can then be used alongside results from the existing policy simulation program, FLIPSIM (Richardson and Nixon 1986) to evaluate changes at the farm level in response to any potential change in relevant policy or management from both economic and environmental perspectives.

The last phase is the interpretation phase. The interpretation phase is where the results of the impact assessment are discussed and evaluated. This analysis will identify key sources of CO_2 equivalents from each crop on each farm and examine trends among crops as well as among farms. Further, the validity, completeness, and robustness of the data and results will be discussed. Finally, conclusions will be drawn and recommendations for further study will be presented.

Methodologies for evaluating environmental impacts

Various methodologies for assessing environmental impacts from production processes have been proposed over the years including methodologies for agriculture. Some methods scored farms by assigning values to different production practices. For instance, the Farmer Sustainability Index (FSI) for cabbage farms in Malaysia (Taylor et al. 1993) and the Environmental Management for Agriculture method in the United Kingdom (Lewis and Bardon 1998) also assess farms by scoring their production practices. Girardin, Bockstaller, and Van der Werf (2000) scored production practices with the AGRO*ECO method, building on an earlier method developed by Leopold et al. (1971).

Other proposed methods focus on ecological indicators, such as pesticide use, biodiversity, and air quality, rather than scores. Vereijken (1997) outlines a method to quantify ecological impact by first defining a set of environmental parameters, each having a threshold that must be achieved. Dalsgaard and Oficial (1997) obtain values in agricultural system characteristics by using bioresource flow diagrams to map the flow of resources through the farm, then directly measuring them. A slightly different approach was proposed by Rossing et al. (1997) to evaluate flower bulb production systems in the Netherlands. They used multi-goal linear programming to optimize ecological objectives subject to a set of environmental, economic, and socioeconomic constraints. One important issue that these methods, except Rossing et al. (1997), do not address is the emission of pollutants to land and water. They are more concerned about general ecological indicators. As greenhouse gas emission is the key focus of this study, only a method that includes GHG emissions and global warming impact is appropriate.

Furthermore, some researchers have approached the agricultural environmental impact from an input-output accounting perspective (Lewis and Bardon 1998; Halberg 1999). In this method, the amount of phosphorus (P) entering the farm, for example, is measured along with the amount leaving the farm. The difference between the two is considered the emission from the farm. However, the input-output method assesses only the impact of farm processes and ignores upstream impacts, such as the carbon released during mineral extraction (Thomassen and de Boer 2005) as well as possibly overestimating emissions. This analysis will address both on-farm and upstream emissions.

History of life cycle assessment

Audsley et al. (1997), Haas, Wetterich, and Geier (2000), and Biewinga (1996) propose using adaptations of the life cycle assessment methodology to address the problem of assessing the environmental impacts for agriculture. Life cycle assessment has its roots in a more general concept developed in the 1960s and 1970s referred to as the life cycle approach. Originally it was used to forecast future energy availability and to estimate energy production processes' emissions to the environment, at every stage. However, since the end of the oil crisis, much of the work done in LCA (especially in agriculture) has come from Europe (Elcock 2007).

One of the two most important developments in the life cycle approach occurred in the early 1990s when researchers started developing ways to estimate potential environmental impacts rather than simply inventorying emissions (Elcock 2007). For instance, a common impact category in contemporary LCA is global warming potential, a more meaningful indicator than simply reporting carbon dioxide (CO_2) emissions. The second development of particular significance occurred when the ISO released the first of its LCA standards, ISO 14040 (1997). Over the course of the 1990s, researchers began to apply LCA to an increasingly broad range of fields. This necessitated an international standard so LCAs could be more comparable (Elcock 2007). The ISO responded with ISO 14040, and has since released several revisions and expansions of the standard.

Through the years, researchers and practitioners have developed numerous expansions and variations on the LCA methodology. Two main types of LCA have emerged, attributional and consequential LCA. In the literature they are known by several names, such as stand-alone and change-oriented LCA (Baumann and Tillman 2004). By whatever name, the difference is in the approach to the life cycle inventory.

Consequential LCAs assess the marginal environmental impacts of some change in a given production system, and the functional units are defined accordingly. It was developed as a way to avoid allocation among coproducts (Thomassen et al. 2008). Attributional LCA, the more common of the two, assesses the impacts of each stage in an existing production system and reports them as a function of the output of that system (Thomassen et al. 2008; Rebitzer et al. 2004; Ekvall and Andrae 2006). Most LCAs of agriculture are attributional in approach and use either a mass or economic allocation scheme where necessary (Thomassen et al. 2008).

LCA in agriculture

The release of the ISO standard enabled researchers to start conducting LCAs on agricultural processes. Haas, Wetterich, and Geier (2000), Cowell and Clift (1997) and Schmidt (2008) explored how LCA could be adapted and applied to agriculture. The general conclusion is that traditional LCA may not be entirely appropriate for use in agriculture, and that certain modifications or adaptations may have to be made. Haas, Wetterich, and Geier (2000) in particular emphasize that the system boundaries, functional units, and impact categories typically used for LCAs in other industries may not be appropriate for LCAs in agriculture. For instance, a cradle-to-gate analysis is often better suited to agricultural LCA than the cradle-to-grave approaches used in fuel cycle and food LCAs. Because impacts in the consumer and waste-processing stages are relatively small (de Backer et al. 2009), omitting impacts beyond the farm-gate is a reasonable modification.

Numerous life cycle assessments have been conducted to compare different production systems. In animal agriculture, Eriksson (2005) used LCA to evaluate the effect of different feed mixes on the system's environmental burden. LCA has also been used to evaluate crops and cropping systems. For instance, de Backer et al. (2009) studied the case of organic versus conventional leek production. Their results suggested that organic production may be more environmentally sound. Brentrup et al. (2004) and Charles et al. (2006) compare different fertilization schemes in wheat.

LCAs have also been conducted on representative production systems as a way to assess the environmental footprint of an industry. Wang et al. (2007) assessed the life cycle impacts of a summer maize and winter wheat rotation system in the North China Plain. Dalgaard et al. (2008) conducted a life cycle assessment to quantify the environmental impacts of soybean meal produced in Argentina, Europe's major supplier.

Issues to be addressed in this study

LCA is the most appropriate of the methodologies reviewed for meeting the objective of the study. However, there are two issues with the LCAs included in this review: most of them were conducted outside the United States and most of those studies assumed a monocrop system. This is problematic because the production systems of the U.S. are different from those in Europe. The second issue, related to the first, is that if the potential impacts are given as per hectare or per farm, the monocrop assumption is unrealistic in an analysis of American production systems, as most U.S. farms are multicrop systems.

CHAPTER II

LIFE CYCLE INVENTORY AND IMPACT ASSESSMENT

This study performs attributional life cycle assessments for 95 representative farms. This is done by building a Microsoft Excel spreadsheet model to estimate agricultural input quantities (from farm level budget data) and quantify the associated carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) emissions. The inputs included in this study are fuel, electricity, fertilizer, feed, herbicides, and insecticides. Other emission sources included are direct and indirect GHG emission from soils and animal sources.

The system may be divided into two broad stages, upstream and on-farm. Emissions in the upstream stage include those from mineral extraction, refining, and transporting the inputs to the system. On-farm emissions are those resulting from the use of the inputs as well as emissions from on-farm processes such as tillage, manure handling, and enteric fermentation in ruminant animals.

The following model was designed and programmed into Excel to catalogue, characterize, and normalize life cycle inventory results.

Fixed cost allocation

The data for the fixed inputs fuel/lubricants, utilities, and repairs/maintenance are unallocated between crops. However, the stated functional unit is CO_2 equivalents per yield unit. To achieve this, an allocation scheme must be developed. The ISO recommends avoiding allocation whenever possible, and otherwise to use physical relationships, such as mass-balance, or economic relationships to allocate among coproducts, or in this case, crops. Thomassen et al. (2008) and Luo et al. (2009) use and compare both approaches. This study, due to constraints in the data set, uses an economic allocation system. Variable costs are used as a driver for allocating unallocated fixed inputs. The process is as follows. First, because the data are in terms of dollar expenditure, they must be converted to quantities of the inputs using agricultural price data assembled by National Agricultural Statistics Service (NASS) of the U.S. Department of Agriculture (USDA 2009):

$$\text{UFixed input}_{\text{J,T}}=\text{Expenditure}_{\text{J,T}}\div\text{Price}_{\text{J,T}}$$

where:

$\text{UFixed input}_{J,T}$ = unallocated fixed input *J* used by the farm in year *T*.

$\text{Expenditure}_{J,T}$ = dollar expense incurred by the farm on the input *J* in year *T*.

$\text{Price}_{J,T}$ = dollar price of input *J* in year *T*.

Each input can then be allocated among enterprises on the farm with the following relation:

$$\text{AFixed input}_{I,J,T} = \text{Frac}_{I} \times \text{UFixed input}_{J,T}$$

where:

$\text{AFixed input}_{Z,J,T}$ = fixed input *J* allocated to enterprise *Z* in year *T*

$$\text{Frac}_{Z} = {}^{\text{Variable costs}_{\text{Z}}}\!\big/_{\sum_{\text{Z}}\text{Variable costs}_{\text{Z}}}$$

Each enterprise now has associated fixed and variable inputs. Henceforth, each enterprise is treated as a separate production system, with emissions calculated separately.

Greenhouse gas emissions from fixed inputs

Greenhouse gas emission from fuel can be divided into two phases: upstream and combustion. Upstream emissions include those from extraction, refining, and transportation. The combustion phase includes the GHGs released when the fuel is actually burned. Carbon dioxide emissions from fuel are therefore given by the following relation:

$$\mathrm{CO_2}_{fuel,Z,T} = \sum_I \left[\left(\mathrm{fuelEF}_{C,U,I} \times \mathrm{mmBtu}/\mathrm{gallon}_I \times \mathrm{lb}/\mathrm{g}\right) + \mathrm{fuelEF}_{C,B,I}\right] \times \mathrm{fuel}_{I,Z,T}$$

where:

$\mathrm{CO_2}_{fuel,Z}$ = carbon dioxide emission from fuel for enterprise Z in year T, lb CO_2 yr^{-1}

$\mathrm{fuelEF}_{C,U}$ = fuel_I upstream emission factor for carbon dioxide , g CO_2 $mmBtu^{-1}$

$\mathrm{fuelEF}_{C,B}$ = fuel_I combustion emission factor for carbon dioxide , lb CO_2 $gallon^{-1}$

$\mathrm{mmBtu}/\mathrm{gallon}_I$ = energy content of a gallon of fuel I

I = fuel type

$\mathrm{fuel}_{I,Z,T}$ = amount of fuel I used by enterprise Z in year T

Methane emission from fuel is given by the relation:

$$\mathrm{CH_4}_{fuel,Z,T} = \sum_I \left(\left[\left(\mathrm{fuelEF}_{M,U,I} \times \mathrm{mmBtu}/\mathrm{gallon}_I\right) + \mathrm{fuelEF}_{M,B,I}\right] \times \mathrm{lb}/\mathrm{g} \times \mathrm{fuel}_{I,Z,T}\right)$$

where:

$CH_{4_{fuel,Z,T}}$ = methane emission from fuel I from enterprise Z in year T, lb CH_4 yr^{-1}

$fuelEF_{M,U}$ = $fuel_I$ upstream emission factor for methane, g CH_4 $mmBtu^{-1}$

$fuelEF_{M,B}$ = $fuel_I$ combustion emission factor for methane, g CH_4 $gallon^{-1}$

I = fuel type

Nitrous oxide emission from fuels is given in the following equation:

$$N_2O_{fuel,Z,T} = \sum_I \left(\left[\left(fuelEF_{N,U,I} \times {}^{mmBtu}/_{gallon_I} \right) + fuelEF_{N,B,I} \right] \times {}^{lb}/_{g} \times fuel_{I,Z,T} \right)$$

where:

$N_2O_{fuel,Z,T}$ = nitrous oxide emission from fuel I from enterprise Z in year T, lb N_2O yr^{-1}

$fuelEF_{N,U}$ = $fuel_I$ upstream emission factor for nitrous oxide, g N_2O $mmBtu^{-1}$

$fuelEF_{N,B}$ = $fuel_I$ combustion emission factor for nitrous oxide, g N_2O $gallon^{-1}$

I = fuel type

Emissions from the three greenhouse gases evaluated here are converted into carbon dioxide equivalents by the relation below. Each type of emission is multiplied by its 100 year global warming potential (GWP) relative to CO_2 (Solomon et al. 2007). GWP is the amount of carbon dioxide required for an effect equal to that caused by the non-CO_2 gas. The total CO_2 equivalents are given by

$$\mathrm{CO_2eq}_{fuel,Z,T} = \sum_{fuel}\left[\left(\mathrm{CO_2}_{fuel,Z,T} \times \mathrm{GWP}_C\right) + \left(\mathrm{CH_4}_{fuel,Z,T} \times \mathrm{GWP}_M\right) + \left(\mathrm{N_2O}_{fuel,Z,T} \times \mathrm{GWP}_N\right)\right]$$

where:

Total $\mathrm{CO_2eq}_{fuel}$ = the total carbon dioxide equivalent of carbon dioxide, methane, and nitrous oxide emissions from fuel, lb CO_2 eq yr^{-1}

GWP_C = the global warming potential of carbon dioxide relative to carbon dioxide

GWP_M = the global warming potential of methane relative to carbon dioxide

GWP_N = the global warming potential of nitrous oxide relative to carbon dioxide

The generation of electricity also results in GHG emission. This study inventories carbon dioxide, methane and nitrous oxide emissions for seven power generation pathways: nuclear fission, natural gas, coal, woody biomass, herbaceous biomass, hydroelectric, and wind. The CO_2 equivalent per million Btu is a weighted average of emission factors, with weights assigned according to the power mix in the area of the farm.

$$\mathrm{CO_2eq}_{EG,Z,T} = \{\left[\left(\mathrm{CO_2}_{NF} \times \mathrm{GWP}_C\right) + \left(\mathrm{CH_4}_{NF} \times \mathrm{GWP}_M\right) + \left(\mathrm{N_2O}_{NF} \times \mathrm{GWP}_N\right)\right] \times \mathrm{Prop}_{NF} + \left[\left(\mathrm{CO_2}_{NG} \times \mathrm{GWP}_C\right) + \left(\mathrm{CH_4}_{NG} \times \mathrm{GWP}_M\right) + \left(\mathrm{N_2O}_{NG} \times \mathrm{GWP}_N\right)\right] \times \mathrm{Prop}_{NG} + \left[\left(\mathrm{CO_2}_{CL} \times \mathrm{GWP}_C\right) + \left(\mathrm{CH_4}_{CL} \times \mathrm{GWP}_M\right) + \left(\mathrm{N_2O}_{CL} \times \mathrm{GWP}_N\right)\right] \times \mathrm{Prop}_{CL} + \left[\left(\mathrm{CO_2}_{WB} \times \mathrm{GWP}_C\right) + \left(\mathrm{CH_4}_{WB} \times \mathrm{GWP}_M\right) + \left(\mathrm{N_2O}_{WB} \times \mathrm{GWP}_N\right)\right] \times \mathrm{Prop}_{WB} + \left[\left(\mathrm{CO_2}_{HB} \times \mathrm{GWP}_C\right) + \left(\mathrm{CH_4}_{HB} \times \mathrm{GWP}_M\right) + \left(\mathrm{N_2O}_{HB} \times \mathrm{GWP}_N\right)\right] \times \mathrm{Prop}_{HB} + \left[\left(\mathrm{CO_2}_{\mathrm{WND}} \times \mathrm{GWP}_C\right) + \left(\mathrm{CH_4}_{\mathrm{WND}} \times \mathrm{GWP}_M\right) + \left(\mathrm{N_2O}_{WND} \times \mathrm{GWP}_N\right)\right] \times$$

$$\mathrm{Prop}_{WND} + \left[\left(\mathrm{CO}_{2_{HE}} \times \mathrm{GWP}_C\right) + \left(\mathrm{CH}_{4_{HE}} \times \mathrm{GWP}_M\right) + (\mathrm{N}_2\mathrm{O}_{HE} \times \mathrm{GWP}_N)\right] \times \mathrm{Prop}_{HE}\Big\} \times \mathrm{electricity}_{Z,T}$$

where:

$\mathrm{CO}_2\mathrm{eq}_{EG,Z}$ = The total carbon dioxide equivalent of carbon dioxide, methane, and nitrous oxide emissions from electricity generation, g CO_2eq mmBtu^{-1} yr^{-1}

Prop = the proportion of power mix generated from the subscripted pathway

NF = nuclear fission

CL = coal

WB = woody biomass

HB = herbaceous biomass

WND = wind

HE = hydroelectric

and

$$\mathrm{electricity}_Z = \mathrm{KWH}_{Z,T} \times {}^{\mathrm{mmBtu}}/_{\mathrm{KWH}}$$

where:

electricity = electricity used in enterprise *Z* in year *T*, mmBtu yr^{-1}

KWH = electricity used in enterprise *Z* in year *T*, KWH yr^{-1}

Greenhouse gas emissions from the fixed inputs of enterprise *Z* in year *T* are then given in the relation:

$$\mathrm{CO}_{2\ eq_{fixed,Z,T}} = \mathrm{CO}_2\mathrm{eq}_{fuel,Z,T} + \mathrm{CO}_2\mathrm{eq}_{Elec,Z,T}$$

Carbon sequestration

Agricultural operations have the potential to emit carbon as well as to sequester carbon in soils. This analysis uses the IPCC tier 1 default method to estimate sequestration (Eggleston et al. 2006). In the tier 1 method, all C sequestered in annual crop biomass is assumed to be released during decomposition. The method also assumes that C losses are in the form of CO_2 as current research is insufficient to quantify soil emissions of methane and carbon monoxide. Carbon sequestration is therefore the change in soil organic carbon (SOC). This method estimates the change in SOC down to 11.8 inches (30 cm) over a designated study period by taking the difference in SOC at the end of the period and SOC at the beginning of the period. SOC is estimated by multiplying a reference value by factors for temperature, rainfall, cultivation level, and tillage practices. This relation is given by:

$$\Delta \mathrm{SOC}_{Z,T} = {}^{\mathrm{SOC}_{Z,0} - \mathrm{SOC}_{Z,0-t}}\!/_{\mathrm{D}}$$

where:

$\Delta \mathrm{SOC}_{Z,T}$ = change in soil organic carbon under enterprise Z in year T, tonnes yr^{-1}

0 = end of study period

$0 - t$ = beginning of study period

D = length of study period, years

and

$$\mathrm{SOC}_Z = \mathrm{SOC}_{Ref,Z} \times \mathrm{F}_{Lu,Z} \times \mathrm{F}_{Mg,Z} \times \mathrm{F}_{O,Z} \times \mathrm{A}_Z \times {}^{\mathrm{ha}}\!/_{\mathrm{acre}}$$

where:

SOC_{Z} = soil organic carbon in soil under enterprise *Z*, tonnes ha^{-1}

$\mathrm{SOC}_{Ref,Z}$ = reference carbon stock under native vegetation of soils in enterprise *Z*, tonnes ha^{-1}

$\mathrm{F}_{Lu,Z}$ = factor associated with land use

$\mathrm{F}_{Mg,Z}$ = factor associated with management regime

$\mathrm{F}_{O,Z}$ = factor associated with input of organic matter

A_{Z}= area, acres

The change in SOC is then converted into pounds of CO_2 sequestration by:

$$\mathrm{CO}_{2_{seq,Z,T}} = \Delta\mathrm{SOC}_{Z,T} \times -{}^{44}/_{12} \times {}^{\mathrm{lb}}/_{\mathrm{tonne}}$$

where:

$\mathrm{CO}_{2_{seq,Z,T}}$ = carbon dioxide sequestered by enterprise *Z* in year *T*, lb CO_2 yr^{-1}

$-{}^{44}/_{12}$ = molecular ratio of carbon to carbon dioxide, negative because sequestration is a “negative” emission.

Direct and indirect GHG emissions from managed soils

This analysis also includes direct and indirect emissions from managed agricultural soils. Direct N_2O emissions are those resulting from the nitrification and denitrification of manure nitrogen, while indirect emissions are the product of ammonia and NO_x emissions (Eggleston et al. 2006). The main GHG emitted from farm soils is N_2O, however, liming results in direct CO_2 emission and flooded rice fields emit CH_4. The IPCC outlines tier 1 methods for estimating emissions from managed soils for all three

GHGs (Eggleston et al. 2006). The IPCC method for estimating direct nitrous oxide emissions from managed soils is:

$$\text{Direct } \mathrm{N_2O}_{soils,Z,T} = \left(\mathrm{N_2O-N}_{inputs,Z,T} + \mathrm{N_2O-N}_{OS,Z,T} + \mathrm{N_2O-N}_{waste,Z,T}\right) \times {}^{\mathrm{N_2O}}/_{\mathrm{N_2O-N}} \times {}^{\mathrm{lb}}/_{\mathrm{kg}}$$

where:

Direct $\mathrm{N_2O}_{soils,Z,T}$ = direct nitrous oxide emissions from managed soils under enterprise *Z* in year *T*, lb N_2O yr^{-1}

${}^{\mathrm{N_2O}}/_{\mathrm{N_2O-N}}$ = conversion factor for N_2O-N to N_2O

and

$$\mathrm{N_2O-N}_{inputs,Z,T} = \left(\mathrm{N}_{sfert,Z,T} + \mathrm{N}_{ofert,Z,T} + \mathrm{N}_{residue,Z,T}\right) \times \mathrm{EF}_{inputs,Z}$$

where:

$\mathrm{N_2O-N}_{inputs,Z,T}$ = direct N_2O-N emissions from N inputs to enterprise *Z* in year *T*, kg N_2O-N yr^{-1}

$\mathrm{N}_{sfert,Z,T}$ = synthetic N fertilizer applied in enterprise *Z* in year *T*, kg N yr^{-1}

$\mathrm{N}_{ofert,Z,T}$ = organic N fertilizer (manure) applied in enterprise *Z* in year *T*, kg N yr^{-1}

$\mathrm{N}_{residue,Z,T}$ = N in crop residues left in field for enterprise *Z* in year *T*, kg N yr^{-1}

$\mathrm{EF}_{inputs,Z}$ = emission factor for N inputs to enterprise *Z*

and

$$\mathrm{N_2O-N}_{OS,Z,T} = \mathrm{OS}_{Z,T} \times \mathrm{EF}_{orgsoils,Z} \times {}^{\mathrm{ha}}/_{\mathrm{acre}}$$

where:

$N_2O - N_{OS,Z,T} =$ direct N_2O-N emissions from managed organic soils under enterprise *Z* in year *T*, kg N_2O-N yr^{-1}

$OS_{Z,T}$ = area organic soils under enterprise *Z* in year *T*, acres

$EF_{orgsoils,Z}$ = N_2O-N emission factor for organic soils under enterprise *Z*

and

$$N_2O - N_{waste,Z,T} = \sum_B \left(\sum_G \left(N_{B,G,Z,T} \times Nit_B \times Mass_{B,G,Z,T} \div 1000 \times 365 \times Prop_{Prp,B,G,Z,T} \times Prop_{culled,B,G,Z,T} \times Life_{B,G,Z} \times Prop_{herd,B,G,Z,T} \right) \right) \times EF_{directwaste,Z}$$

where:

$N_2O - N_{waste,Z,T}$ = direct N_2O-N emissions from animal waste to grazed soils, kg N_2O-N yr^{-1}

$N_{B,G,Z,T}$ = Number of cows in enterprise *Z* in year *T*

Nit_B = nitrogen excreted by cattle, kg N (1000 kg animal mass)$^{-1}$ day^{-1}

$Mass_{B,G,Z,T}$ = average mass of cows in enterprise *Z* in year *T*, kg head^{-1}

$Prop_{Prp,B,G,Z,T}$ = proportion of manure handled in a pasture, range, and paddock system

$Prop_{culled,B,G,Z,T}$ = proportion of the herd culled in enterprise *Z* in year *T*

$Prop_{herd,B,G,Z,T}$ = proportion gender *G* in the herd

$Life_{B,G,Z}$ = average lifespan of cows in enterprise *Z*, years

$\mathrm{EF}_{directwaste,Z}$ = direct N_2O-N emission factor for animal waste to grazed soils under enterprise *Z*, kg N_2O-N (kg manure N applied to land)$^{-1}$

B denotes the type of cow, dairy or non-dairy

G denotes the sex of the cow, male or female

The IPCC method for estimating indirect N_2O emissions from managed soils is given by the following:

$$\text{Indirect } \mathrm{N_2O}_{soils,Z,T} = \Big[\mathrm{N}_{sfert,Z.T} \times \mathrm{Frac_{GASF}} + \Big[\mathrm{N}_{ofert,Z,T} + \textstyle\sum_B\Big(\sum_G\Big(\mathrm{N}_{B,G,Z,T} \times \mathrm{Nit}_B \times \mathrm{Mass}_{B,G,Z,T} \div 1000 \times 365 \times \mathrm{Prop}_{Prp,B,G,Z,T} \times \mathrm{Prop}_{culled,B,G,Z,T} \times \mathrm{Life}_{B,G,Z} \times \mathrm{Prop}_{herd,B,G,Z,T}\Big)\Big) \times \mathrm{Frac_{GASM}}\Big] \times \mathrm{EF}_{indirectwaste,Z}\Big] \times {}^{\mathrm{N_2O}}\!/_{\mathrm{N_2O-N}} \times {}^{\mathrm{lb}}\!/_{\mathrm{kg}}$$

where:

$\text{Indirect } \mathrm{N_2O}_{soils,Z,T} =$ indirect N_2O emissions from managed soils in enterprise *Z* in year *T*, lbs year^{-1}

$\mathrm{Frac_{GASF}}$ = proportion of synthetic fertilizer nitrogen volatilizes as ammonia and NO_x

$\mathrm{Frac_{GASM}}$ = proportion of manure nitrogen that volatilizes as ammonia and NO_x

$\mathrm{EF}_{indirectwaste,Z}$ = indirect N_2O-N emission factor for animal waste on grazed soils under enterprise *Z*, kg N_2O-N (kg NH_3-N + NO_x-N volatilized)$^{-1}$

All other variables are as previously defined.

See Eggleston et al. (2006) for estimation procedures for nitrogen in all crop residues except cotton. Nitrogen from cotton residues are estimated by a function provided by Ed Barnes at Cotton Incorporated. It combines data from three studies: Mauney et al. (1994); Reddy, Baker and Jenkins (1985); and Craig (2002).

Certain other agricultural practices also result in direct emission of greenhouse gases. The two practices included in the IPCC tier 1 methodology and therefore this analysis are carbon dioxide emissions from liming and methane emissions from rice production (Eggleston et al. 2006). Carbon dioxide emission is estimated by:

$$\mathrm{CO_2}_{liming,Z,T} =$$

$$\left[\left(\mathrm{LM}_{Z,T} \times \mathrm{EF}_{limestone}\right) + \left(\mathrm{DM}_{Z,T} \times \mathrm{EF}_{dolomite}\right)\right] \times {}^{\mathrm{CO_2}}/_{\mathrm{CO_2}\,-\,\mathrm{C}} \times {}^{\mathrm{lb}}/_{\mathrm{tonne}}$$

where:

$\mathrm{CO_2}_{liming,Z,T}$ = direct carbon dioxide emissions from liming of soils in enterprise *Z* in year *T*, lbs

$\mathrm{LM}_{Z,T}$ = limestone applied to land in enterprise *Z* in year *T*, tonnes

$\mathrm{EF}_{limestone}$ = carbon dioxide emission factor for limestone, tonnes C (tonnes limestone)$^{-1}$

$\mathrm{DM}_{Z,T}$ = dolomite applied to land in enterprise *Z* in year *T*, tonnes

$\mathrm{EF}_{dolomite}$ = carbon dioxide emission factor for dolomite, tonnes C (tonnes dolomite)$^{-1}$

${}^{\mathrm{CO_2}}/_{\mathrm{CO_2}\,-\,\mathrm{C}}$ = conversion factor, CO_2-C to CO_2

The IPCC emission factors for limestone and dolomite represent the maximum possible emissions based on molecular ratios. For this reason they may overestimate emissions.

Direct methane emissions from rice cultivation are estimated by the IPCC with the following:

$$\mathrm{CH}_{4_{direct,rice,Z,T}} = \mathrm{EF}_{rice} \times \mathrm{SF}_{cult,Z,T} \times \mathrm{SF}_{prev,Z,T} \times \mathrm{Days}_{Z,T} \times \mathrm{A}_{Z,T} \times {}^{\mathrm{lb}}/_{\mathrm{Gg}}$$

where:

$\mathrm{CH}_{4_{direct,rice,Z,T}}$ = direct methane emissions from rice cultivation in enterprise *Z* in year *T*, lbs

EF_{rice} = default emission factor for methane emissions for soils in rice cultivation, kg ha^{-1} day^{-1}

$\mathrm{SF}_{cult,Z,T}$ = scaling factor for the water regime in the cultivation period

$\mathrm{SF}_{prev,Z,T}$ = scaling factor for the water regime before the cultivation period

$\mathrm{Days}_{Z,T}$ = number of days in the cultivation of rice in enterprise *Z* in year *T*

$\mathrm{A}_{Z,T}$ = area under rice cultivation in enterprise *Z* in year *T*, hectares

Total carbon dioxide equivalent emissions from soils are given by:

$$\mathrm{CO}_{2\ eq_{soils,Z,T}} = \mathrm{CO}_{2_{liming,Z,T}} + \left(\mathrm{CH}_{4_{direct,rice,Z,T}} \times \mathrm{GWP}_M\right) + \left(\mathrm{N_2O}_{soils,Z,T} \times \mathrm{GWP}_N\right)$$

Direct and indirect GHG emissions from livestock

This analysis also uses IPCC tier 1 methodology to estimate emissions from livestock. Nitrous oxide and methane are the main GHGs of concern. The methodology includes emission factors for methane and nitrous oxide emissions from manure management, as well as methane emissions from enteric fermentation.

The IPCC provides default nitrous oxide emission factors for 16 manure management systems, however, only the 5 most common to the United States are included here (Eggleston et al. 2006). They are anaerobic lagoons, liquid systems, solid storage systems, and dry lots. Daily spread systems are also accounted for, but because emissions from spread manure are included in the emissions from managed soils, they are omitted here to avoid double counting. It should be noted, however, that an allocation problem arises with emissions from livestock. While all other agricultural products included in this analysis require one season to produce, some livestock require more than one. Though heifers and steer calves generally stay on the farm for only one season, cows and bulls are normally on the farm for multiple seasons. The stated functional unit of this study is pounds of CO_2 equivalent per hundredweight of meat (leaving the farm gate). Therefore, emissions from culled cows and bulls must be included. However, to avoid attributing emissions (from soils, enteric fermentation, and manure management) of the entire herd to the small portion culled in that year, GHG emissions from livestock are multiplied by the proportion of the herd culled in that year and the average cow lifespan. This was also done for emissions from manure applied to soils. Under the described allocation scheme, emissions from the entire cattle cycle are accounted for in the year the cow is slaughtered.

Therefore, direct nitrous oxide emissions from non-dairy cow manure management are given in the following relation:

$$\mathrm{N_2O}_{directmanure,ND,Z,T} = \sum_G \left[\sum_I \left(\mathrm{N}_{ND,G,Z,T} \times \mathrm{Nit_{ND}} \times \mathrm{mass}_{ND,G,Z,T} \div 1000 \times 365 \times \mathrm{Prop}_{I,ND,Z,T} \times \mathrm{EF}_{MM,I} \times {}^{\mathrm{N_2O}}\!/_{\mathrm{N_2O-N}} \times {}^{\mathrm{lb}}\!/_{\mathrm{kg}} \right) \times \mathrm{Prop}_{culled,ND,G,Z,T} \times \mathrm{Prop}_{herd,ND,G,Z,T} \times \mathrm{Life}_{ND,G,Z} \right]$$

where:

$\mathrm{N_2O}_{directmanure,ND,G,Z,T}$ = direct nitrous oxide emission from manure management of non-dairy cattle in enterprise *Z* in year *T*, lbs yr^{-1}

$\mathrm{mass}_{I,ND,G,Z,T}$ = average mass of non-dairy cattle in enterprise *Z* in year *T*, kg $head^{-1}$

Nit_{ND} = nitrogen excreted by non-dairy cattle, kg N (1000 kg animal mass)$^{-1}$ day^{-1}

$\mathrm{Prop}_{I,ND,Z,T}$ = proportion of non-dairy cattle manure managed in system *I* in enterprise *Z* in year *T*

$\mathrm{Prop}_{culled,ND,Z,T}$ = proportion of the non-dairy herd culled in enterprise *Z* in year *T*

$\mathrm{Prop}_{herd,ND,G,Z,T}$= proportion of gender *G* in the non-dairy herd

$\mathrm{Life}_{ND,G,Z}$ = average lifespan of non-dairy cows in enterprise *Z*, years

$\mathrm{EF}_{MM,I}$ = emission factor associated with manure management system *I*, N_2O-N (kg N excreted)$^{-1}$

I denotes the manure management system

G denotes sex of cows, male or female

Direct nitrous oxide emissions from dairy cow manure management are given in the following relation:

$$N_2O_{directmanure,D,Z,T} = \left[\sum_I \left(N_{D,Z,T} \times \mathrm{Nit_D} \times \mathrm{mass}_{D,Z,T} \div 1000 \times 365 \times \right.\right.$$

$$\left.\left. \mathrm{Prop}_{I,D,Z,T} \times \mathrm{EF}_{MM,I} \times {}^{N_2O}/_{N_2O-N} \times {}^{lb}/_{kg} \right)\right] \times \mathrm{Prop}_{culled,D,Z,T} \times \mathrm{Life}_{D,Z}$$

where:

$N_2O_{directmanure,D,Z,T}$ = direct nitrous oxide emission from manure management of dairy cattle in enterprise *Z* in year *T*, lbs yr^{-1}

$\mathrm{mass}_{I,D,Z,T}$ = average mass of dairy cattle in enterprise *Z* in year *T* with manure managed in system *I*, kg head^{-1}

Nit_D = nitrogen excreted by dairy cattle, kg N (1000 kg animal mass)$^{-1}$ day^{-1}

$\mathrm{Prop}_{I,D,Z,T}$ = proportion of dairy cattle manure managed in system *I* in enterprise *Z* in year *T*

$\mathrm{Prop}_{culled,D,Z,T}$ = proportion of the dairy herd culled in enterprise *Z* in year *T*

$\mathrm{Life}_{D,Z}$ = average lifespan of dairy cows in enterprise *Z*, years

$\mathrm{EF}_{MM,I}$ = direct emission factor associated with manure management system *I*, N_2O-N (kg N excreted)$^{-1}$

I = manure management system

Indirect nitrous oxide emissions from non-dairy cattle are estimated by the following:

$$N_2O_{indirectmanure,ND,Z,T} = \sum_G \left[\sum_I \left(N_{ND,G,Z,T} \times \mathrm{Nit}_{\mathrm{ND}} \times \mathrm{mass}_{ND,G,Z,T} \div 1000 \times 365 \times \mathrm{Prop}_{I,ND,G,Z,T} \times \mathrm{Frac}_{\mathrm{GasMS}_I} \times \mathrm{EF}_{indirectwaste,Z} \times {}^{N_2O}/_{N_2O - N} \times {}^{\mathrm{lb}}/_{\mathrm{kg}} \right) \times \mathrm{Prop}_{culled,ND,G,Z,T} \times \mathrm{Prop}_{herd,ND,G,Z,T} \times \mathrm{Life}_{ND,G,Z} \right]$$

where:

$N_2O_{indirectmanure,ND,G,Z,T}$ = indirect nitrous oxide emissions from non-dairy

cattle manure in enterprise *Z* in year *T*, lbs

$\mathrm{Frac}_{\mathrm{GasMS}_I}$ = fraction of manure N that volatilizes as ammonia and NO_x

$\mathrm{EF}_{indirectwaste,Z}$ = indirect N_2O-N emission factor for animal waste to grazed soils, kg N_2O-N (kg NH_3-N + NO_x-N volatilized)$^{-1}$

All other variables are as defined in the direct emission equation.

Indirect N_2O emissions from dairy cows are as follows:

$$N_2O_{indirectmanure,ND,Z,T} = \left[\sum_I \left(N_{D,Z,T} \times \mathrm{Nit}_{\mathrm{D}} \times \mathrm{mass}_{D,Z,T} \div 1000 \times 365 \times \mathrm{Prop}_{I,D,Z,T} \times \mathrm{Frac}_{\mathrm{GasMS}_I} \times \mathrm{EF}_{indirectwaste,Z} \times {}^{N_2O}/_{N_2O - N} \times {}^{\mathrm{lb}}/_{\mathrm{kg}} \right)\right] \times \mathrm{Prop}_{culled,D,Z,T} \times \mathrm{Life}_{D,Z}$$

$N_2O_{indirectmanure,D,Z,T}$ = indirect nitrous oxide emissions from dairy cattle manure in enterprise *Z* in year *T*, lbs

$\mathrm{Frac}_{\mathrm{GasMS}_I}$ = fraction of manure N that volatilizes as ammonia and NO_x

$\mathrm{EF}_{indirectwaste,Z}$ = indirect N_2O-N emission factor for animal waste to grazed soils, kg N_2O-N (kg NH_3-N + NO_x-N volatilized)$^{-1}$

All other variables are as defined in the direct emission equation.

The IPCC tier 1 method also provides for the estimation of methane emissions from manure management (Eggleston et al. 2006). The method uses emission factors dependent on temperature and the type of animal. As before, only emissions from dairy and non-dairy cattle are included in this analysis. Also, the same transformation with regard to the cattle life cycle must be made here as well. The following is the relation for non-dairy cattle:

$$\mathrm{CH_4}_{manure,ND,Z,T} = \sum_G \left(\mathrm{EF}_{manure,ND,\tau} \times \mathrm{N}_{ND,G,Z,T} \times {}^{\mathrm{lb}}/_{\mathrm{kg}} \times \mathrm{Prop}_{culled,ND,Z,T} \times \mathrm{Prop}_{herd,ND,G,Z,T} \times \mathrm{Life}_{ND,G,Z}\right)$$

where:

$\mathrm{CH_4}_{manure,ND,GZ,T}$ = methane emission from manure management of non-dairy cattle in enterprise *Z* in year *T*, lbs

$\mathrm{EF}_{manure,ND,\tau}$ = manure management methane emission factor for non-dairy cattle with average annual temperature τ, kg head^{-1} year^{-1}

$\mathrm{N}_{ND,G,Z,T}$ = number of non-dairy cattle in enterprise *Z* in year *T*

$\mathrm{Prop}_{culled,ND,G,Z,T}$ = proportion of the non-dairy herd culled in enterprise *Z* in year *T*

$\mathrm{Prop}_{herd,ND,G,Z,T}$ = proportion gender *G* in the herd

$\mathrm{Life}_{ND,G,Z}$ = average lifespan of non-dairy cows in enterprise *Z*, years

G denotes the sex of the cow, male or female

The relation for dairy cattle:

$$\mathrm{CH_4}_{manure,D,Z,T} = \mathrm{EF}_{manure,D,\tau} \times \mathrm{N}_{manure,D,Z,T} \times {}^{\mathrm{lb}}\!/_{\mathrm{g}} \times \mathrm{Prop}_{culled,D,Z,T} \times \mathrm{Life}_{D,Z}$$

where:

$\mathrm{CH_4}_{manure,D,Z,T}$ = methane emission from manure management of dairy cattle in enterprise Z in year T, lbs

$\mathrm{EF}_{manure,D,\tau}$ = manure management methane emission factor for dairy cattle with average annual temperature τ, kg head^{-1} year^{-1}

$\mathrm{N}_{D,Z,T}$ = number of dairy cattle in enterprise Z in year T

$\mathrm{Prop}_{culled,D,Z,T}$ = proportion of the dairy herd culled in enterprise Z in year T

$\mathrm{Life}_{D,Z}$ = average lifespan of dairy cows in enterprise Z, years

Methane is also released from enteric fermentation of ruminant animals. The IPCC tier 1 approach estimates these emissions with the following relations. For non-dairy cattle:

$$\mathrm{CH_4}_{enteric,ND,Z,T} = \sum_G \left(\mathrm{EF}_{enteric,ND} \times \mathrm{N}_{ND,G,Z,T} \times {}^{\mathrm{lb}}\!/_{\mathrm{g}} \times \mathrm{Prop}_{culled,ND,G,Z,T} \times \mathrm{Prop}_{herd,ND,G,Z,T} \times \mathrm{Life}_{ND,G,Z}\right)$$

where:

$\mathrm{CH_4}_{enteric,ND,Z,T}$ = methane emission from enteric fermentation of non-dairy cattle in enterprise Z in year T, lbs

$\mathrm{EF}_{enteric,ND}$ = enteric fermentation methane emission factor for non-dairy cattle, kg head^{-1} year^{-1}

The relation for dairy cattle

$$\mathrm{CH_4}_{enteric,D,Z,T} = \mathrm{EF}_{enteric,D} \times \mathrm{N}_{D,Z,T} \times {}^{\mathrm{lb}}/_{\mathrm{g}} \times \mathrm{Prop}_{culled,D,Z,T} \times \mathrm{Life}_{D,Z}$$

where:

$\mathrm{CH_4}_{enteric,D,Z,T}$ = methane emission from enteric fermentation of dairy cattle in enterprise *Z* in year *T*, lbs

$\mathrm{EF}_{enteric,D}$ = enteric fermentation methane emission factor for dairy cattle, kg head^{-1} year^{-1}

$\mathrm{N}_{D,Z,T}$ = number of dairy cattle in enterprise *Z* in year *T*

Emissions from livestock are combined by:

$$\mathrm{CO_2}\,eq_{livestock,Z,T} = \left(\mathrm{N_2O}_{manure,ND,Z,T} + \mathrm{N_2O}_{manure,D,Z,T}\right) \times \mathrm{GWP_M} + \left(\mathrm{CH_4}_{manure,ND,Z,T} + \mathrm{CH_4}_{manure,D,Z,T} + \mathrm{CH_4}_{enteric,ND,Z,T} + \mathrm{CH_4}_{enteric,D,Z,T}\right) \times \mathrm{GWP_N}$$

Special considerations for livestock operations

Because diaries and cow-calf operations often include feeds grown both on- and off-farm, livestock operations have stages in their life cycles that crops do not. For off-farm feeds, the emissions from growing and transportation to the farm are counted as upstream emissions and are assessed using Energy Information Administration emission standards for heavy duty diesel vehicles made since 1996 (Department of Energy 2010b) and average miles per gallon from (Davis, Diegel, and Boundy 2010) . This is done assuming distances on an individual basis. In consultation with the representative dairy coordinator, a system of transportation tiers was developed to capture the variability in feed transportation distances. Tier A assumes the feed truck travels a distance of 20 miles one way, so 40 miles per trip. Tiers B and C assume round trips of 100 and 200 miles, respectively. If the farm both purchases and grows the feed crop in question, only emissions from portion sold are attributed to the crop enterprise. Emissions from the portion fed are added to the GHG gas emission from the livestock enterprise. Per-unit emissions from purchased feed crops are assumed to be similar for a region. If the farm purchases all its feed requirements, per-unit emissions from a nearby farm that produces the feed crop are used. If a farm purchases a feed it also produces, the per-unit emission from the farm are used to estimate the emissions of the purchased feed. The equations used to estimate these are as follows. Emissions from purchased feeds for dairies are:

$$\mathrm{CO}_{2\ eq_{\mathrm{Bfeed},D,Z,T}} = \sum_Y \left(\mathrm{CO}_{2\ eq_{\mathrm{U},Y}} + \mathrm{CO}_{2\ eq_{\mathrm{Tr},Y,Z,T}}\right) \times \mathrm{Bfeed}_{Y,Z,T}$$

where:

$\mathrm{CO}_{2\ eq_{\mathrm{Bfeed},D,Z,T}}$ = carbon dioxide equivalent emissions from purchased feed in enterprise *Z* in year *T*, lbs

$\mathrm{CO}_{2\ eq_{\mathrm{U},Y}}$ = carbon dioxide equivalent emissions from production of feed *Y*, lb ton^{-1}

$\mathrm{Bfeed}_{Y,Z,T}$ = amount of feed *Y* purchased for enterprise *Z* in year *T*, tons

$\mathrm{CO}_{2\ eq_{\mathrm{Tr},Y,Z,T}}$ = carbon dioxide equivalent from transportation of feed *Y* used in enterprise *Z* in year *T*, lb ton^{-1}

Y = the type of feed

and

Carbon dioxide equivalent from transportation of feed ($CO_{2\ eq_{Tr,Y,Z,T}}$) is estimated by the following:

$$CO_{2\ eq_{Tr,Y,Z,T}} = \left[\left(\left(\left(\text{fuelEF}_{C,U,I} \times \text{GWP}_\text{C} + \text{fuelEF}_{M,U,I} \times \text{GWP}_\text{M} + \text{fuelEF}_{N,U,I} \times \text{GWP}_\text{N}\right) \times {}^{\text{mmBtu}}\!/_{\text{gal}_I} \times {}^{\text{lb}}\!/_{\text{g}}\right) + \text{fuelEF}_{C,B,I}\right) \times {}^{1}\!/_{{}^{\text{miles}}\!/_{\text{gal}_{Y,Z,T}}} + \left(\left(\text{truckEF}_{M,B,I} \times \text{GWP}_\text{M} + \text{truckEF}_{N,B,I} \times \text{GWP}_\text{N}\right) \times {}^{\text{lb}}\!/_{\text{g}}\right)\right] \times {}^{\text{mile}}\!/_{\text{trip}_{Y,Z,T}} \times {}^{1}\!/_{{}^{\text{ton feed}}\!/_{\text{trip}_{Y,Z,T}}}$$

where:

$\text{fuelEF}_{C,U,I}$, $\text{fuelEF}_{M,U,I}$, $\text{fuelEF}_{N,U,I}$, $\text{fuelEF}_{C,B,I}$, GWP_C, GWP_M, GWP_N, and I are defined previously

$\text{truckEF}_{M,B,I}$ = amount of methane released by a heavy-duty diesel truck, g mile^{-1}

$\text{truckEF}_{N,B,I}$ = amount of nitrous oxide released by a heavy-duty diesel truck, g mile^{-1}

${}^{\text{miles}}\!/_{\text{trip}_{Y,Z,T}}$ = roundtrip distance traveled during each shipment to the farm for feed Y used in enterprise Z in year T

${}^{\text{ton feed}}/_{\text{trip}_{Y,Z,T}}$ = tons of feed *Y* shipped to the farm on each trip for use in enterprise *Z* in year *T*

${}^{\text{miles}}/_{\text{gal}_{Y,Z,T}}$ = fuel mileage for vehicles transporting feed *Y* to enterprise *Z* in year *T*

Similarly, non-dairy feeds are given by the following:

$$\text{CO}_{2\ eq_{\text{Bfeed},ND,Z,T}} = \sum_G \Big(\sum_Y \big(\text{CO}_{2\ eq_{U,Y}} + \text{CO}_{2\ eq_{\text{Tr},Y,Z,T}}\big) \times \text{Bfeed}_{Y,Z,T} \times \text{Prop}_{culled,ND,G,Z,T} \times \text{Prop}_{herd,ND,G,Z,T} \times \text{Life}_{ND,G,Z}\Big)$$

where:

$\text{CO}_{2\ eq_{\text{Bfeed},ND,Z,T}}$ = carbon dioxide equivalent emissions from purchased feed in enterprise *Z* in year *T*, lbs

$\text{CO}_{2\ eq_{\text{U},Y}}$ = carbon dioxide equivalent emissions from production of feed *Y*, lb ton^{-1}

$\text{Bfeed}_{Y,Z,T}$ = amount of feed *Y* purchased for enterprise *Z* in year *T*, tons

$\text{CO}_{2\ eq_{\text{Tr},Y,Z,T}}$ = carbon dioxide equivalent from transportation of feed *Y* used in enterprise *Z* in year *T*, lb ton^{-1}

Y = the type of feed

$\text{Prop}_{culled,ND,G,Z,T}$, $\text{Prop}_{\text{herd,ND,G,Z,T}}$, $\text{Life}_{ND,G,Z}$ and $\text{CO}_{2\ eq_{\text{Tr},Y,Z,T}}$) are defined previously.

The question of how to assign emissions from feeds grown and used totally on-farm is also an issue. Because the stated functional units of this analysis is pounds of CO_2 equivalent per harvest unit (in this case, hundredweights of milk or meat sold at the farm gate) and per pound of harvested crop, crops used for feed are treated as an input to the livestock operation. Therefore, the GHG emission from a crop used for dairy feed is simply added into the total per year emission of the enterprise. Emission from growing cow-calf feed is calculated separately for bulls and cows. The cow and bull portions (feed attributed to the herd times the proportion of each gender to the total herd) of the feed are multiplied by the proportion of culled cows to total cows and the proportion of culled bulls to total bulls, and the average life spans of cows and of bulls, respectively. They are then added to the total GHG emission from the livestock enterprise before the normalization stage.

Greenhouse gas emissions from variable inputs

Both the ISO and Luo et al. (2009) recommend using physical relationships in the allocation of environmental impacts among coproducts when possible. The data permit this approach to be used for impacts from the variable inputs of production because they are listed by crop (the “coproducts” of the farm system) in the dataset. The major emitters of greenhouse gases among variable inputs for crops, and therefore the focus of this analysis, are fertilizers and pesticides. Also, as the IPCC method for calculating carbon sequestration is individualized by crop, there is no need to allocate it.

Emissions from fertilizer and pesticides, like those of other farm inputs, can be separated into two categories: upstream and on-farm. As before, the upstream includes emissions from all the product’s processes before it reaches the farm. On-farm emissions are those resulting from using the input.

The model includes emissions from the following fertilizers: ammonia (NH_3), urea ($(NH_2)_2CO$), ammonium nitrate (NH_4NO_3), phosphoric acid (H_3PO_4), potash (K_2O), and lime ($CaCO_3$). Carbon dioxide emissions from fertilizer are estimated by the following:

$$\mathrm{CO_2}_{fert,Z,T} = \sum_I \left[\mathrm{fertEF}_{C,U,I} \times {}^{\mathrm{lb}}/_{\mathrm{g}} \times \mathrm{fert}_{I,Z,T} \right]$$

where:

$\mathrm{CO_2}_{fert,Z,T}$ = carbon dioxide emissions from fertilizer use by enterprise Z in year T, lb CO_2 yr^{-1}

$\mathrm{fertEF}_{C,U}$ = fertilizer$_I$ upstream emission factor for carbon dioxide emission, g CO_2 ton^{-1}

I = fertilizer type

and

$$\mathrm{fert}_{I,Z,T} = \mathrm{fertExpenditure}_{I,Z,T} \div \mathrm{fertPrice}_{I,T}$$

where:

$\mathrm{fert}_{I,Z,T}$ = amount of fertilizer I used by enterprise Z in year T, tons

$\mathrm{fertexpenditure}_{I,Z,T}$ = expenditure on fertilizer I in enterprise Z in year T, dollars

$\mathrm{fertprice}_{I,T}$ = price of fertilizer I in year T, dollars ton^{-1}

Methane emissions from fertilizer are estimated by the following:

$$\mathrm{CH_4}_{fertZ,T} = \sum_I \left[\mathrm{fertEF}_{M,U,I} \times {}^{\mathrm{lb}}/_{\mathrm{g}} \times \mathrm{fert}_{I,Z,T} \right]$$

where:

$\mathrm{CH}_{4_{fert,Z,T}}$ = methane emissions from fertilizer use by enterprise *Z* in year *T*, lb CH_4 yr^{-1}

$\mathrm{fertEF}_{M,U,I}$ = fertilizer$_I$ upstream emission factor for methane, g CH_4 ton^{-1}

I = fertilizer type

Nitrous oxide emissions from fertilizer are estimated by the following:

$$\mathrm{N_2O}_{fert,Z,T} = \sum_I \left[\mathrm{fertEF}_{N,U,I} \times {}^{\mathrm{lb}}/_{\mathrm{g}} \times \mathrm{fert}_{I,Z,T}\right]$$

where:

$\mathrm{N_2O}_{fert,Z,T}$ = nitrous oxide emissions from fertilizer use by enterprise *Z* in year *T*, lb N_2O yr^{-1}

$\mathrm{fertEF}_{N,U,I}$ = fertilizer$_I$ upstream emission factor for nitrous oxide, g N_2O ton^{-1}

I = fertilizer type

On-farm emissions from fertilizer application are included in the emission from managed soils calculations.

Greenhouse gas emissions from herbicides and insecticides are also included in this model. Again, as the data are in terms of expenditure, they must be indexed back to quantities using NASS prices (USDA 2009). Carbon dioxide emissions from herbicides are given by the following:

$$\mathrm{CO}_{2_{herb,Z,T}} = \sum_I \left[\mathrm{herbEF}_{C,U,I} \times {}^{\mathrm{lb}}/_{\mathrm{g}} \times {}^{\mathrm{ton}}/_{\mathrm{gallon}_I} \times \mathrm{herb}_{I,Z,T}\right]$$

where:

$\mathrm{CO}_{2_{herb,Z,T}}$ = upstream carbon dioxide emissions from herbicide use by enterprise *Z* in year *T*, lb CO_2 yr^{-1}

$\text{herbEF}_{C,U,I}$ = herbicide$_I$ upstream emission factor for carbon dioxide, g CO_2 ton^{-1}

$^{\text{ton}}/_{\text{gallon}_I}$ = tons of herbicide$_I$ per gallon of herbicide$_I$

I = type of herbicide

and

$$\text{herb}_{I,Z,T} = \text{herbExppenditure}_{I,Z,T} \div \text{herbPrice}_{I,T}$$

where:

$\text{herb}_{I,Z,T}$ = amount of herbicide I used by enterprise Z in year T, tons

$\text{herbExenditure}_{I,Z,T}$ = expenditure on herbicide I in enterprise Z in year T, dollars

$\text{herbPrice}_{I,T}$ = price of herbicide I in year T, dollars gallon^{-1}

Methane emissions from herbicides are given by the following equation:

$$\text{CH}_{4_{herb,Z,T}} = \sum\nolimits_I \left[\text{herbEF}_{M,U,I} \times {}^{\text{lb}}/_{\text{g}} \times {}^{\text{ton}}/_{\text{gallon}_I} \times \text{herb}_{I,Z,T}\right]$$

where:

$\text{CH}_{4_{herb,Z,T}}$ = upstream methane emissions from herbicide use by enterprise Z in year T, lb CH_4 yr^{-1}

$\text{herbEF}_{M,U,I}$ = herbicide$_I$ upstream emission factor for methane, g CH_4 yr^{-1}

I = type of herbicide

Nitrous oxide emissions from herbicides are given by the following:

$$\text{N}_2\text{O}_{herb,Z,T} = \sum\nolimits_I \left[\text{herbEF}_{N,U,I} \times {}^{\text{lb}}/_{\text{g}} \times {}^{\text{ton}}/_{\text{gallon}_I} \times \text{herb}_{I,Z,T}\right]$$

where:

$\mathrm{N_2O}_{fert,Z,T}$ = upstream nitrous oxide emission from herbicide use by enterprise Z in year T, lb N_2O yr^{-1}

$\mathrm{herbEF}_{N,U,I}$ = herbicide$_I$ upstream emission factor for nitrous oxide, g N_2O yr^{-1}

I = type of herbicide

Upstream insecticide emission of carbon dioxide is estimated by:

$$\mathrm{CO_2}_{insc,Z,T} = \mathrm{inscEF}_{C,U} \times {}^{\mathrm{lb}}/_{\mathrm{g}} \times {}^{\mathrm{ton}}/_{\mathrm{gallon}} \times \mathrm{insc}_{Z,T}$$

where:

$\mathrm{CO_2}_{insc,Z,T}$ = upstream carbon dioxide emissions from insecticide use by enterprise Z in year T, lb CO_2 yr^{-1}

$\mathrm{inscEF}_{C,U}$ = insecticide upstream emission factor for carbon dioxide, g CO_2 yr^{-1}

${}^{\mathrm{ton}}/_{\mathrm{gallon}}$ = tons of insecticide per gallon of insecticide

and

$$\mathrm{insc}_{Z,T} = \mathrm{inscExpenditure}_{Z,T} \div \mathrm{inscPrice}_T$$

where:

$\mathrm{insc}_{Z,T}$ = amount of insecticide used by enterprise Z in year T, tons

$\mathrm{inscExpenditure}_T$ = expenditure on insecticide by enterprise Z in year T, dollars

$\mathrm{inscPrice}_T$ = price of pesticide in year T, dollars $gallon^{-1}$

Upstream methane emissions from insecticide are estimated by:

$$\mathrm{CH_4}_{insc,Z,T} = \mathrm{inscEF}_{M,U} \times {}^{\mathrm{lb}}/_{\mathrm{g}} \times {}^{\mathrm{ton}}/_{\mathrm{gallon}} \times \mathrm{insc}_{Z,T}$$

where:

$CH_{4_{insc,Z,T}}$ = upstream methane emissions from insecticide use in enterprise *Z* in year *T*, lb CH_4 yr^{-1}

$inscEF_{M,U}$ = insecticide upstream emission factor for methane, g CH_4 yr^{-1}

Upstream nitrous oxide emissions from insecticide are estimated by:

$$N_2O_{insc,Z,T} = inscEF_{N,U} \times {}^{lb}\!/_{g} \times {}^{ton}\!/_{gallon} \times insc_{Z,T}$$

where:

N_2O_{insc} = upstream nitrous oxide emissions from insecticide use in enterprise *Z* in year *T*, lb N_2O yr^{-1}

$inscEF_{N,U}$ = insecticide upstream emission factor for nitrous oxide, g N_2O yr^{-1}

Emissions from fertilizer, herbicides, and insecticides are converted to CO_2 equivalents and combined by the following relation:

$$CO_2eq_{var,Z,T} = \left[\left(CO_{2_{fert,Z,T}} + CO_{2_{herb,Z,T}} + CO_{2_{insc,Z,T}}\right) \times GWP_C\right] + \left[\left(CH_{4_{fert,Z,T}} + CH_{4_{herb,Z,T}} + CH_{4_{insc,Z,T}}\right) \times GWP_M\right] + \left[\left(N_2O_{fert,Z,T} + N_2O_{herb,Z,T} + N_2O_{insc,Z,T}\right) \times GWP_N\right]$$

Totaling and normalization

According to the ISO, LCA inventories should be normalized over a meaningful functional unit. The inventories of this analysis are normalized into CO_2 equivalents per harvest unit, CO_2 equivalents per acre, and CO_2 equivalents per harvested pound. Harvest units are different for each enterprise and include tons, bushels, pounds, and hundredweights. Results are summed and normalized into CO_2 equivalents per harvest unit, for each enterprise, in the following relation:

$$CO_{2\ eq_{total}}/\text{harvest unit}_{Z,T} = \left(CO_{2\ eq_{fixed,Z,T}} + CO_{2_{seq,Z,T}} + CO_{2\ eq_{soils,Z,T}} + CO_{2\ eq_{livestock,Z,T}} + CO_{2\ eq_{\text{Bfeed},Z,T}} + CO_2\text{eq}_{\text{var,Z,T}}\right) \div \text{Yield}_{Z,T}$$

where:

$CO_{2\ eq_{total}}/\text{harvest unit}_{Z,T}$ = total carbon dioxide equivalents from enterprise *Z* in year *T*, lbs (harvest unit)$^{-1}$

$\text{Yield}_{Z,T}$ = total yield for enterprise *Z* in year *T*, bushels, pounds, tons, or hundredweights

Results are also be normalized over planted acres by the following:

$$CO_{2\ eq_{total}}/\text{planted acre}_{Z,T} = \left(CO_{2\ eq_{fixed,Z,T}} + CO_{2_{seq,Z,T}} + CO_{2\ eq_{soils,Z,T}} + CO_{2\ eq_{livestock,Z,T}} + CO_{2\ eq_{\text{Bfeed},Z,T}} + CO_2\text{eq}_{\text{var,Z,T}}\right) \div \text{A}_{Z,T}$$

where:

$CO_{2\ eq_{total}}/\text{planted acre}_{Z,T}$ = total carbon dioxide equivalents from enterprise *Z* in year *T*, lbs (planted acre)$^{-1}$

$\text{A}_{Z,T}$ = area in enterprise *Z* in year *T*, acres

Finally, GHG emissions are normalized over a common measure of weight, pounds. This facilitates comparison of carbon intensities between crops. The relation to do this is:

$$\left. CO_{2\;eq_{total}} \middle/ \text{harvested lb} \right._{Z,T} = \left(CO_{2\;eq_{fixed,Z,T}} + CO_{2_{seq,Z,T}} + CO_{2\;eq_{soils,Z,T}} + CO_{2\;eq_{livestock,Z,T}} + CO_{2\;eq_{\mathrm{Bfeed},Z,T}} + CO_2\mathrm{eq}_{\mathrm{var,Z,T}}\right) \div \left(\mathrm{Yield}_{Z,T} \times {}^{\mathrm{lbs}}/_{\mathrm{yield\ unit}}\right)$$

where:

$\left. CO_{2\;eq_{total}} \middle/ \text{harvested lb} \right._{Z,T}$ = the total CO_2 equivalent emitted per pound of harvested crop in enterprise *Z* in year *T*, lbs (harvest lb)$^{-1}$

CHAPTER III

DATA RETRIEVAL AND TRANSFORMATION METHODS

The data and key assumptions

The dataset used in this analysis is the Representative Farm Database maintained by the Agricultural and Food Policy Center (AFPC) at Texas A&M University. It consists of a set of agricultural operations for the most important U.S. crops in their principle growing regions, which are updated every two years by interviewing panels of farmers from the area. Discussions with staffers for the U.S. House and Senate Agriculture Committees are the main resource for determining farm locations. The information in the database is the result of each panel's consensus.

The data in the Representative Farm Database consist of basic farm characteristics, as well as economic and financial data on each farm's input costs and revenues including location, size, crop mix, assets, and average receipts. Many regions have two farms with separate producer panels, one moderate-sized farm and one large farm.

This data is used in FLIPSIM (Richardson and Nixon 1986) to simulate the farm-level economic effects of agricultural policy changes. Because most of the studies that use the farms are concerned with financial key output variables (KOVs), the data are in terms of expenditures and must be indexed back to the quantities of fuels, chemicals and fertilizers needed for this study.

Indexing expenditure data back to quantity purchased is done using March 2009 price data from the NASS (USDA 2009) well as 2009 price and generation mix (nuclear, natural gas, coal, hydroelectric, wind, woody biomass, and herbaceous biomass are included) data from the Energy Information Administration (EIA) at the U.S. Department of Energy (DOE 2010a). As the NASS price data are for March, implicit in using them is an assumption that inputs are bought early in the season. For fertilizer and chemical inputs, this may be somewhat realistic. However, electricity and fuel numbers could be affected.

Fuel and fertilizer prices are given by USDA-defined production regions. Although the model is capable of considering emissions from diesel, gasoline, and lubricant oil, for this study it is assumed that all fuel costs are diesel costs. According to the Representative Farm coordinator, diesel makes up the largest share of fuel cost by far.

There are several other ambiguous spending categories in the Representative Farm data. Assumptions were made in each case to standardize them across farms. For instance, in this analysis, nitrogen fertilizer is assumed to be in the form of ammonium nitrate due to limitations in the dataset. Likewise, lime, potassium and phosphorus are assumed to be in the forms of limestone, potash and phosphoric acid, respectively. The joint expenditure on P, K, and lime is apportioned as 50% P and 50% K, except where liming is practiced, in which case the cost is assumed to be 50% lime, 25% P and 25% K. Liming is omitted for all farms except those in the Southeast, and then only on farms for which lime is specifically noted. Also, irrigation fuel costs are allocated evenly between diesel and electricity. Hauling (except for dairies) and drying costs are omitted. Furthermore, custom harvesting and application costs are excluded, so farms relying on custom work may have understated emissions. For dairies and cow-calf operations, emissions from feeds not grown as crops (e.g. minerals) are not inventoried. For cow-calf operations, adult bull and cow weights are assumed to be the respective cull weights. The average life spans are assumed to be 8 years for cows and 4 years for bulls. For dairies, weights for bulls and cows are assumed to be the average cull cow weight. Because the IPCC method for estimating N in crop residues is based on grain yield, NASS state level yield data are used to estimate N in residues of crops grown for silage (USDA 2011).

To estimate emissions (or sequestration) from changes in soil organic carbon (SOC), assumptions about tillage practices must be made. The IPCC methodology measures change in SOC as the simple difference between SOC at the beginning and end of a defined study period (Eggleston et al. 2006). The default factors provided by the IPCC are for a 20 year study period. If no data are available for a farm's tillage practices, full tillage is assumed for the beginning and end of the study period for cropland, and no tillage is assumed for pasture and perennial forage crops. When there are data on tillage practices, the current practice is assumed to be the ending practice and the beginning practice is assumed to be one level below it. For instance, reduced tillage would be the assumption for beginning practice on a no till farm.

Chemical (insecticide and herbicide) prices from NASS are national averages. Defoliant and growth regulator costs are added to herbicide costs. For simplicity, this analysis assumes atrazine to be a proxy for all herbicides and defoliants due to its common usage. In the case of insecticides, GREET provides a default weighted average of several common insecticides. This aggregate is used with the price for synthetic pyrethroid, again because of its common usage.

Emissions from equipment manufacture are omitted from this analysis. Because agricultural machinery is typically used for several years, its allocated manufacturing emissions are generally very small (Wu, Wang, and Huo 2006).

Electricity prices and mixes are state-level. They are annual averages compiled by the Energy Information Administration (EIA) at the United States Department of Energy.

Average temperature and and precipitation data is from the The Weather Channel online climatology database (2011). Monthly average precipitation and temperatures are retrieved for the city or town nearest each farm.

The GREET model

Because a large portion of upstream emissions from farms comes from transportation and fuel, their calculation is necessary for the completeness of this analysis. However, the data and time requirements of undertaking this task were beyond the scope of this study. Therefore, this analysis uses the well known Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model, version 1.8c, to estimate the upstream emission factors for fuel (Wang 2008). The GREET model is an Excel model developed by Michael Wang at the Argonne National Laboratory in Chicago to model fuel cycle pathways over their entire life-cycle, also known as "well-to-wheels analysis." GREET has been evaluated relative to other fuel cycle models (Miller and Theis 2006; Plevin 2009), and used in multiple studies of fuel cycle emission (Huang and Zhang 2006; Zamel and Li 2006; Landis, Miller, and Theis 2007; O'Donnell et al. 2009; Huo, Wu, and Wang 2009; Du, Han, and Peng 2010; Rotz, Montes, and Chianese 2010) GREET is also of interest to practitioners of LCAs in agriculture as it not only models emissions and energy use through the fuel cycle, but also as a part of its biofuels pathways includes inventory data on agricultural inputs such as fertilizer, machinery, electricity production, and chemicals (O'Donnell et al. 2009). This analysis uses GREET-calculated emission factors for fertilizer and chemical production as well.

GREET is used to estimate all upstream emission factors. These include carbon dioxide, methane, and nitrous oxide emission factors for the upstream processes of fuels, fertilizers, pesticides, and electricity. The model is calibrated to assume US refineries with non-California as the default location of the refinery. However, the model can be set to assume a California refinery.

Upstream emission factors were calculated in the following way. First, the desired assumptions were set in the inputs sheet of the GREET model. After running the model with the assumptions, worksheets containing the appropriate emission factors (for petroleum, electricity, and agricultural inputs) were extracted from these sheets and inserted into the spreadsheet model used in this analysis.

The emission factors estimated by GREET are in table 3.1. These factors are used to estimate the upstream (i.e., transportation, manufacture, mineral extraction) GHG emissions from fuel, fertilizer, chemicals, and electricity. Since each factor is an estimate of upstream emissions per unit consumed, they are multiplied by the amounts of the input used on the farm to give the total upstream emission.

Table 3.1 GREET-Estimated Emission Factors

Parameter	Description	Factor	Unit
$fuelEF_{C,U,Diesel}$	CO_2 from diesel combustion	15,443.41	g CO_2 $mmBtu^{-1}$
$fuelEF_{M,U,Diesel}$	CH_4 from diesel combustion	104.52	g CH_4 $mmBtu^{-1}$
$fuelEF_{N,U,Deisel}$	N_2O from diesel combustion	0.25	g N_2O $mmBtu^{-1}$
CO_{2NF}	CO_2 from nuclear electricity	0.00	g CO_2 $mmBtu^{-1}$
CO_{2NG}	CO_2 from natural gas electricity	162,028.15	g CO_2 $mmBtu^{-1}$
CO_{2CL}	CO_2 from coal electricity	345,531.65	g CO_2 $mmBtu^{-1}$
CO_{2WB}	CO_2 from woody biomass electricity	0.00	g CO_2 $mmBtu^{-1}$
CO_{2HB}	CO_2 from herbaceous biomass electricity	0.00	g CO_2 $mmBtu^{-1}$
CO_{2HE}	CO_2 from hydroelectric electricity	0.00	g CO_2 $mmBtu^{-1}$
CO_{2WND}	CO_2 from wind electricity	0.00	g CO_2 $mmBtu^{-2}$
CH_{4NF}	CH_4 from nuclear electricity	0.00	g CH_4 $mmBtu^{-1}$
CH_{4NG}	CH_4 natural gas electricity	9.59	g CH_4 $mmBtu^{-1}$
CH_{4CL}	CH_4 from coal electricity	3.83	g CH_4 $mmBtu^{-1}$
CH_{4WB}	CH_4 from woody biomass electricity	10.47	g CH_4 $mmBtu^{-1}$
CH_{4HB}	CH_4 from herbaceous biomass electricity	10.47	g CH_4 $mmBtu^{-1}$
CH_{4HE}	CH_4 from hydroelectric electricity	0.00	g CH_4 $mmBtu^{-1}$
CH_{4WND}	CH_4 from wind electricity	0.00	g CH_4 $mmBtu^{-1}$
N_2O_{NF}	N_2O from nuclear electricity	0.00	g N_2O $mmBtu^{-1}$
N_2O_{NG}	N_2O from natural gas electricity	3.84	g N_2O $mmBtu^{-1}$
N_2O_{CL}	N_2O from coal electricity	3.38	g N_2O $mmBtu^{-1}$
N_2O_{WB}	N_2O from woody biomass electricity	30.04	g N_2O $mmBtu^{-1}$
N_2O_{HB}	N_2O from herbaceous biomass electricity	30.04	g N_2O $mmBtu^{-1}$
N_2O_{HE}	N_2O from hydroelectric electricity	0.00	g N_2O $mmBtu^{-1}$
N_2O_{WND}	N_2O from wind electricity	0.00	g N_2O $mmBtu^{-1}$
$fertEF_{C,U,Ammonium Nitrate}$	upstream CO_2 emission from Ammonium Nitrate	1,207,648.69	g CO_2 ton^{-1}
$fertEF_{C,U,Phosphoric Acid}$	upstream CO_2 emission from phosphoric acid	888,410.00	g CO_2 ton^{-1}
$fertEF_{C,U,Potash}$	upstream CO_2 emission from potash	591,880.24	g CO_2 ton^{-1}
$fertEF_{C,U,Lime}$	upstream CO_2 emission from lime	539,147.32	g CO_2 ton^{-1}
$fertEF_{M,U,Ammonium Nitrate}$	upstream CH_4 emission from ammonium nitrate	1,327.17	g CH_4 ton^{-1}
$fertEF_{M,U,Phosphoric Acid}$	upstream CH_4 emission from phosphoric acid	1,603.05	g CH_4 ton^{-1}
$fertEF_{M,U,Potash}$	upstream CH_4 emission from potash	875.69	g CH_4 ton^{-1}
$fertEF_{M,U,Lime}$	upstream CH_4 emission from lime	816.77	g CH_4 ton^{-1}
$fertEF_{N,U,Ammonium Nitrate}$	upstream N_2O emission from ammonium nitrate	6,248.81	g N_2O ton^{-1}
$fertEF_{N,U,Phosphoric Acid}$	upstream N_2O emission from phosphoric acid	16.27	g N_2O ton^{-1}
$fertEF_{N,U,Potash}$	upstream N_2O emission from potash	8.61	g N_2O ton^{-1}
$fertEF_{N,U,Lime}$	upstream N_2O emission from lime	7.25	g N_2O ton^{-1}
$herbEF_{C,U,Atrazine}$	upstream CO_2 emission from atrazine	15,033,608.12	g CO_2 ton^{-1}
$herbEF_{M,U,Atrazine}$	upstream CH_4 emission from atrazine	21,772.56	g CH_4 ton^{-1}
$herbEF_{N,U,Atrazine}$	upstream N_2O emission from atrazine	167.84	g N_2O ton^{-1}
$inscEF_{C,U}$	upstream CO_2 emission from insecticide	21,712,217.50	g CO_2 ton^{-1}
$inscEF_{M,U}$	upstream CH_4 emission from insecticide	31,916.41	g CH_4 ton^{-1}
$inscEF_{N,U}$	upstream N_2O emission from insecticide	269.66	g N_2O ton^{-1}

Source: Wang (2008)

On-farm emissions: IPCC Tier 1 and other sources

The Intergovernmental Panel on Climate Change (IPCC) provides a methodology for conducting greenhouse gas emission inventories (Eggleston et al. 2006). Their methodology is divided into three numbered tiers, 1 being the most general and 3 being the most detailed (Eggleston et al. 2006). Due to time and data constraints, this study uses the tier 1 method, except where tier 2 country specific emission factors are available from the EPA.

The tier 1 method used here can be found in Eggleston et al. (2006).The default values used are given in table 3.2. Again, if the term, "input" is loosely defined to include animal waste, organic soils, and cows, the EF values are GHG emission per unit of GHG-emitting input. They are then multiplied by the input specific to the farm to get the total on-farm emission.

The remaining values of table 3.2 are conversion factors. The GWP values are the global warming potentials of carbon dioxide, methane, and nitrous oxide. These values represent the global warming effect (how much heat each of the greenhouse gases traps) relative to an equivalent mass of CO_2. The factors can be multiplied by the emission of their respective GHGs to obtain CO_2 equivalents. The Nit values convert number of cattle to the nitrogen excreted in their waste, which is then multiplied by the appropriate emission factor (EF_{MM}) to get N_2O-N emissions. N_2O-N emissions are converted to N_2O using the N_2O/N_2O-N value, which is the molecular weight ratio of N to N_2O. Similarly, the CO_2/CO_2-C value is the molecular weight ratio of C to CO_2. It is used to convert changes in soil organic carbon to CO_2 emissions. This calculation is detailed in the *Life Cycle Inventory and Impact Assessment* chapter.

Table 3.2 IPCC Tier 1 Default Emission Factors

Parameter	Description	Factor	Unit
CO_2/CO_2-C	Converts CO_2-C emissions to CO_2	3.67	index
N_2O/N_2O-N	Converts N_2O-N emissions to N_2O	1.57	index
GWP_C	Global warming potential of CO_2 relative to CO_2	1	index
GWP_M	Global warming potential of CH_4 relative to CO_2	25	index
GWP_N	Global warming potential of N_2O relative to CO_2	298	index
D	Time dependence of C sequestration factors	20	Years
$EF_{inputs,Z}$	N emission factor for N inputs to crops	0.01	kg N_2O-N (kg N)$^{-1}$
$EF_{orgsoils,Z}$	N emission factor for organic soils	8	kg N_2O-N (ha)$^{-1}$
$EF_{waste,Z}$	N emission factor for animal wastes on grazed pastures	0.02	kg N_2O-N (kg N)$^{-1}$
$EF_{limestone}$	C emission factor for $CaCO_3$ applied	0.12	tonnes C (tonnes limestone)$^{-1}$
$EF_{dolomite}$	C emission factor for $CaMg(CO_3)_2$	0.13	tonnes C (tonnes dolomite)$^{-1}$
Nit_{ND}	N excreted by non-dairy cattle	0.31	kg N (1000 kg animal mass)$^{-1}$ day^{-1}
Nit_D	N excreted by dairy cattle	0.44	kg N (1000 kg animal mass)$^{-1}$ day^{-1}
$EF_{MM,anaerobic\ lagoons}$[a]	N emission factor for anaerobic lagoon manure management systems	0	kg N_2O-N (kg N excreted)$^{-1}$
$EF_{MM,liquid\ system}$[a]	N emission factor for liquid manure management systems	0.005	kg N_2O-N (kg N excreted)$^{-1}$
$EF_{MM,solid\ storage}$[a]	N emission factor for solid storage manure management systems	0.005	kg N_2O-N (kg N excreted)$^{-1}$
$EF_{MM,drylot}$[a]	N emission factor for dry lot manure management systems	0.02	kg N_2O-N (kg N excreted)$^{-1}$
$EF_{enteric,ND}$	CH_4 emission factor for enteric fermentation in non-dairy cattle	53	kg CH_4 head^{-1} year^{-1}
$EF_{enteric,D}$	CH_4 emission factor for enteric fermentation in dairy cattle	140	kg CH_4 head^{-1} year^{-1}
$Frac_{GASF}$	proportion of synthetic fertilizer N that volatilizes as ammonia and NOx	.1	Index
$Frac_{GASM}$	proportion of urine and dung N that volatilizes as ammonia and NOx	.2	Index
$Frac_{GasMSdrylot}$	Proportion of urine and dung that volatilizes as ammonia and NOx in drylot manure management	.2	Index
$Frac_{GasMSliquid}$	Proportion of urine and dung that volatilizes as ammonia and NOx in liquid system manure management	.4	Index
$EF_{indirectwaste}$	indirect N_2O-N emission factor for animal waste on grazed soils under enterprise Z	.01	kg N_2O-N (kg NH_3-N + NOx-N volatilized)$^{-1}$

Source: Eggleston et al. (2006), except where noted.
[a]These values are U.S. specific factors from EPA (2011).

The values in table 3.2 are common to all the farms in the database. Values that change between farms are given by farm in Appendix B.

Combustion emission factors were obtained from the EPA. They are the amounts of GHGs released when fuel is combusted. For on-farm emissions, where quantity of fuel used is know, the factors are per unit consumed. So they are multiplied by the quantities of fuel used to estimate emissions. However, for off-farm fuel emissions, such as those from transporting purchased feed to the farm, the factors are per mile traveled. These factors are given in table 3.3.

Table 3.3 EPA Combustion Emission Factors

Parameter	Description	Factor	Unit
$FuelEF_{C,B,Diesel}$[a]	CO_2 emission from diesel combustion	22.2	lb gal^{-1}
$FuelEF_{M,B,Diesel}$	CH_4 emission from diesel combustion	1.44	g gal^{-1}
$FuelEF_{N,B,Diesel}$	N_2O emission from diesel combustion	0.26	g gal^{-1}
$truckEF_{M,B,Diesel}$	CH_4 emission from heavy-duty trucks	0.0051	g $mile^{-1}$
$truckEF_{N,B,Diesel}$	N_2O emission from heavy-duty trucks	0.048	g $mile^{-1}$

Source: EPA (2011), except where noted.
[a]This value obtained from EPA (2005).

CHAPTER IV

RESULTS

The model was used to perform life cycle greenhouse gas inventories and impact assessments for 95 representative farms. These farms are divided (and named) by their primary crop. Often, there are two representative farms in the same location, one moderate sized operation and a larger operation. The numbers in their names refer to acres or number of cows. The categories are grain farms, wheat farms, rice farms, cotton farms, dairies, and cow-calf operations. While life cycle inventories and impact assessments were performed for greenhouse gas emissions for all crops on all farms, only the emissions for the titular crop(s) are presented in the main body of this work. For emissions from each farm's other crops, see appendix A. The results are further divided by category and normalized over planted acres of the crop (or head of cattle in the herd) and pound of production leaving the farm.

Heijungs and Kleijn elaborate on the interpretation phase of LCA (2001). They outline five numerical approaches: contribution analysis, perturbation analysis, uncertainty analysis, comparative analysis, and discernibility analysis. This study, by presenting GHG emissions for each farm disaggregated by source category, uses both contribution analysis and comparative analysis. Not only is the GHG emission per pound of production presented for each farm, but also the relative contributions (less the carbon sequestration from changing soil organic carbon stocks) of the following source categories for crop farms: fuel, electricity, fertilizer, pesticides, and soils. For livestock operations, emissions from fuel, electricity, manure management, livestock, and off-farm feeds are the source categories. The individual farm GHG emission estimates along with the relative contributions allow comparative analysis on two levels. First, emissions per pound of production can be compared between farms based on characteristics such as irrigation, size, and location, and crop cultivars. Second, the relative GHG contributions of each source category can be compared between farms.

Furthermore, each farm has its own specific set of assumptions. These are reported in appendix B. Because life cycle assessment is so broad in scope, each practitioner must make a set of assumptions to make the analysis feasible. There is no way to standardize these assumptions across LCAs. Also, within the guidelines set out by the ISO for LCA, there is great liberty in defining system boundaries, functional units, and normalization techniques. Different combinations of these parameters will give (sometimes drastically) different results. Taken together, these characteristics of LCA make results from different studies difficult to compare.

Corn farms

The first group of representative farms analyzed is the corn farms. All but one of the farms (Texas Panhandle Grain 3760) produce either sorghum or soybeans. The farms are located throughout the United States. The farms are different sizes and have different cropping systems. Therefore the farm size, enterprise size, pounds CO_2 per acre in the enterprise and pounds of CO_2 per pound of production are given for corn, by farm, categorized into irrigated and non-irrigated, and sorted by the CO_2 per pound of production. The relative contributions of the five source categories are also reported for corn. Corn is assumed to be at 15.5% moisture and weight 56 pounds per bushel (Murphy 1993).

As expected, per-acre emissions are higher on average for irrigated corn than non-irrigated at 9,408 and 5,623 pounds per acre, respectively (table 4.1). Likewise, emissions per pound of corn production are on average higher for irrigated corn than for non-irrigated corn at 0.901 and 0.664 pounds, respectively. In cases where there is a large and small farm in the same location, the larger farm tends to have lower emissions. This suggests that larger operations are more carbon efficient.

Table 4.1 GHG Emission Summary for Corn Farms

Farm Name	Farm Size (acres)	Enterprise size (acres)	Per-acre CO_2 emission (lbs CO_2/acre)	GHG intensity (lbs CO_2 eq/lb corn)
Irrigated				
Nebraska Feedgrain 4300	4300	1935	5465	0.488
Nebraska Feedgrain 4300-food grade corn	4300	645	5886	0.546
Nebraska Feedgrain 2400	2400	900	7653	0.683
Nebraska Feedgrain 2400-food grade corn	2400	900	7653	0.683
Texas Panhandle Grain 3760	3760	1252	12815	0.915
Texas Northern Plains Feedgrain 8000	8000	3120	13631	1.106
Texas Northern Plains Feedgrain 3000	3000	960	13702	1.112
Texas Uvalde Grain 1200	1200	500	8453	1.677
Mean			*9408*	*0.901*
Non-irrigated				
Iowa Feedgrain 3400	3400	2040	3135	0.303
Iowa Feedgrain 1350	1350	880	3969	0.394
Missouri Feedgrain 4000	4000	2200	5783	0.580
Tennessee Feedgrain 2200	2200	1100	5091	0.627
Indiana Feedgrain 2200	2200	1100	5988	0.629
Tennessee Feedgrain 900	900	400	5145	0.634
Texas Hill County Grain 2000	2000	1000	3332	0.661
Indiana Feedgrain 1000	1000	500	7058	0.681
North Dakota Feedgrain 8000	8000	2450	4603	0.715
South Carolina Grain 3500	3500	2100	4586	0.731
North Dakota Feedgrain 2500	2500	500	5213	0.745
Texas Blacklands Grain 1600	1600	1000	3602	0.757
Missouri Feedgrain 1850	1850	900	7339	0.904
South Carolina Grain 1800	1800	525	4202	0.938
Mean			*4932*	*0.664*

The average CO_2 equivalent for corn in table 4.1 (0.901 and 0.664 lbs/lb corn) is higher than the 0.246 pounds of CO_2 equivalent per pound of corn reported by Kim and Dale (2003). However, they include emissions from Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, and Wisconsin. Of these, only grain farms from Indiana and Iowa are included in this analysis. The results from Iowa (0.303 and 0.394 lbs CO_2 equivalent/lb corn) correspond more closely to Kim and Dale's results. Kim and Dale also omit nitrous oxide emissions from decomposing plant residue, while this study includes them. From outside the Corn Belt, this analysis also includes farms from Texas, Nebraska, Tennessee, and South Carolina, which all have higher corn GHG emissions due to differences in productivity. Farms from these states inflate the average relative to the Kim and Dale study.

Table 4.2 presents the relative contributions of 5 source categories to total GHG emission for corn by farm, divided into irrigated and non irrigated systems. Fuel and electricity make up a large percentage of emissions in irrigated corn cropping systems in Texas relative to irrigated corn in Nebraska. However, fertilizer contributions to GHG emissions are smaller for Texas irrigated farms relative to irrigated corn farms in Nebraska. Contributions from electricity and fuel are generally larger for all irrigated corn.

Table 4.2 Proportion of GHG Emission of Each Input Category to Entire Production Chain Emissions for Corn Farms

Farm Name	Fuel	Electricity	Fertilizer	Pesticides	Soils
Irrigated					
Nebraska Feedgrain 2400	6.79%	4.97%	58.16%	22.52%	4.28%
Nebraska Feedgrain 2400-food grade corn	6.79%	4.97%	58.16%	22.52%	4.28%
Nebraska Feedgrain 4300	7.63%	8.00%	55.91%	19.44%	5.86%
Nebraska Feedgrain 4300-food grade corn	7.50%	7.71%	52.19%	24.39%	5.27%
Texas Northern Plains Feedgrain 3000	14.79%	13.05%	22.30%	45.86%	2.76%
Texas Northern Plains Feedgrain 8000	14.44%	12.26%	30.38%	38.46%	2.77%
Texas Panhandle Grain 3760	13.81%	11.00%	47.45%	21.79%	3.38%
Texas Uvalde Grain 1200	15.26%	11.98%	37.86%	30.96%	1.82%
Non-irrigated					
Indiana Feedgrain 1000	3.80%	2.27%	59.94%	26.18%	4.54%
Indiana Feedgrain 2200	5.22%	2.94%	55.19%	28.73%	4.91%
Iowa Feedgrain 1350	5.98%	1.51%	50.70%	32.03%	6.95%
Iowa Feedgrain 3400	7.08%	2.57%	47.44%	31.47%	8.78%
Missouri Feedgrain 1850	5.20%	5.38%	45.41%	38.15%	3.42%
Missouri Feedgrain 4000	5.20%	1.18%	46.47%	39.23%	5.33%
North Dakota Feedgrain 2500	7.17%	3.43%	56.72%	25.39%	4.15%
North Dakota Feedgrain 8000	2.12%	1.69%	64.46%	23.87%	4.33%
South Carolina Grain 1800	3.38%	1.37%	55.62%	33.52%	3.04%
South Carolina Grain 3500	7.04%	3.25%	53.11%	29.75%	3.92%
Tennessee Feedgrain 900	5.64%	1.28%	55.67%	29.82%	4.52%
Tennessee Feedgrain 2200	7.42%	0.91%	57.43%	26.30%	4.93%
Texas Blacklands Grain 1600	8.74%	1.09%	61.39%	21.24%	4.09%
Texas Hill County Grain 2000	2.94%	0.79%	56.09%	32.92%	4.11%

Soybean farms

None of the representative grain farms grow corn without one of two crops in rotation, soybeans or sorghum. Therefore for the grain farms, this study reports emissions for the two main crops, rather than just the titular crop.

The first of the secondary crops reported is soybeans. Soybeans are assumed to be at 13% moisture and weigh 60 pounds per bushel (Murphy 1993).

Greenhouse gas emissions from soybeans are given in table 4.3. Per pound production emissions are on average lower for irrigated than for non-irrigated at 0.376

and 0.537 pounds. This result should be interpreted with caution, though, as there are only two farms that produce irrigated soybeans, and they are in the same location. The average emission is lower for irrigated soybeans because average GHG emission per acre is almost equal for irrigated and non-irrigated soybeans, but yields are generally lower for non-irrigated soybeans. Interestingly, three out of the seven pairs of large and small farms, the Missouri, Tennessee, and South Carolina large farms had higher emissions per pound of soybean. While Missouri is in a major grain producing region, Tennessee and South Carolina are not. Nebraska, Iowa, Indiana, and North Dakota are soybean producing states. This suggests that there may be a correlation between production efficiency and carbon efficiency.

Table 4.3 GHG Emission Summary for Soybean Farms

Farm Name	Farm Size (acres)	Enterprise size (acres)	Per-acre CO_2 emission (lbs CO_2/acre)	GHG intensity (lbs CO_2 eq/lb soybean)
Irrigated				
Nebraska Feedgrain 4300	4300	1290	1222	0.339
Nebraska Feedgrain 2400	2400	600	1608	0.412
Mean			*1415*	*0.376*
Non-irrigated				
Iowa Feedgrain 3400	3400	1360	974	0.325
Missouri Feedgrain 2050	2050	1025	1283	0.389
Iowa Feedgrain 1350	1350	470	1226	0.393
Tennessee Feedgrain 900	900	400	1292	0.449
Missouri Feedgrain 4000	4000	1800	1427	0.449
Indiana Feedgrain 2200	2200	1100	1758	0.488
Tennessee Feedgrain 2200	2200	800	1683	0.561
South Carolina Grain 1800	1800	700	1191	0.567
South Carolina Grain 3500	3500	700	1191	0.567
Missouri Feedgrain 1850	1850	900	1690	0.626
South Carolina Grain 3500 double crop soybean	3500	700	1215	0.633
North Dakota Feedgrain 8000	8000	4000	1329	0.678
North Dakota Feedgrain 2500	2500	1500	1330	0.693
Indiana Feedgrain 1000	1000	500	2234	0.702
Mean			*1416*	*0.537*

Here again, the results from this analysis are higher than in the literature. Kim and Dale report CO_2 equivalent emissions of 0.159 and 0.163 pounds per pound of soybean production (Kim and Dale 2005). The current study's estimate of emissions from soybean production is higher than Kim and Dale's because they do not include emissions from decomposing residues and because they only include farms from the Corn Belt. Production efficiencies are different between the Corn Belt and other states. If the current study's estimates for non-irrigated soybeans in Iowa are compared to Kim and Dale's result, they are much closer than the average for all farms, especially when the differences is in system boundaries are taken into account.

Table 4.4 Proportion of GHG Emission of Each Input Category to Entire Production Chain Emissions for Soybean Farms

Farm Name	Fuel	Electricity	Fertilizer	Pesticides	Soils
Irrigated					
Nebraska Feedgrain 2400	19.39%	18.52%	5.43%	49.70%	6.96%
Nebraska Feedgrain 4300	18.96%	23.42%	0.00%	49.67%	7.95%
Non-irrigated					
Indiana Feedgrain 1000	6.47%	3.87%	10.70%	73.83%	5.14%
Indiana Feedgrain 2200	11.56%	6.51%	8.65%	65.89%	7.39%
Iowa Feedgrain 1350	7.27%	1.83%	4.15%	80.28%	6.47%
Iowa Feedgrain 3400	9.17%	3.33%	3.58%	76.64%	7.28%
Missouri Feedgrain 1850	7.46%	7.72%	0.00%	79.06%	5.76%
Missouri Feedgrain 2050	5.84%	1.52%	0.00%	83.35%	9.28%
Missouri Feedgrain 4000	6.33%	1.43%	0.00%	84.20%	8.04%
North Dakota Feedgrain 2500	10.23%	4.90%	5.03%	74.63%	5.21%
North Dakota Feedgrain 8000	3.33%	2.65%	6.76%	81.56%	5.70%
South Carolina Grain 1800	9.37%	3.80%	8.92%	71.52%	6.39%
South Carolina Grain 3500	9.54%	4.41%	2.70%	78.40%	4.95%
South Carolina Grain 3500 double crop soybean	10.72%	4.95%	2.65%	77.22%	4.46%
Tennessee Feedgrain 900	7.84%	1.77%	4.94%	79.22%	6.22%
Tennessee Feedgrain 2200	9.89%	1.21%	8.06%	74.40%	6.43%

Table 4.4 gives the relative contributions of the five source categories for the soybean production chain, again divided into irrigated and non-irrigated systems. Fuel and electricity contribute more to the GHG emissions of irrigated soybeans than for non-irrigated soybeans. Fertilizer contributions are lower than other crops, owing in part to the nitrogen fixing nature of soybeans. The majority of GHG emissions in non-irrigated systems come from pesticides, and pesticides account for a plurality of GHG emissions in irrigated soybeans.

Grain sorghum farms

The representative grain farms in Texas rotate grain sorghum, rather than soybeans, with corn. Sorghum yields are given in hundredweights, so no volume-weight transformations are needed.

Emissions from grain sorghum are presented in table 4.5. The average GHG emissions for irrigated and non-irrigated sorghum production are 0.967 and 0.751 pounds CO_2 equivalent per pound of sorghum production, respectively. Again, the larger farms had lower emissions than their smaller counterparts. However, because the farms are all in Texas and the sample size is small, the robustness of the averages is unknown. There are no comparable LCAs for grain to sorghum with which to compare.

Table 4.5 GHG Emission Summary for Sorghum Farms

Farm Name	Farm size (acres)	Enterprise size (acres)	Per-acre CO_2 emission (lbs CO_2/acre)	GHG intensity (lbs CO_2 eq/lb sorghum)
Irrigated				
Texas Uvalde Grain 1200	1200	250	6171	0.595
Texas Northern Plains Feedgrain 3000	3000	240	9525	1.070
Texas Northern Plains Feedgrain 8000	8000	280	10994	1.235
Mean			*8897*	*0.967*
Non-irrigated				
Texas Blacklands Grain 1600	1600	300	4224	0.592
Texas Hill County Grain 2000	2000	500	5020	0.749
Texas Northern Plains Feedgrain 8000	8000	587	2763	0.912
Mean			*4002*	*0.751*

The relative contributions of the source categories to the sorghum production chain are presented in table 4.6. Again, fuel and electricity percentages are larger in irrigated systems than in non-irrigated systems. Also, Hill County and Blacklands Texas farms had higher contributions from fertilizer than farms in West Texas.

Table 4.6 Proportion of GHG Emission of Each Input Category to Entire Production Chain Emissions for Sorghum Farms

Farm Name	Fuel	Electricity	Fertilizer	Pesticides	Soils
Irrigated					
Texas Northern Plains Feedgrain 3000	13.68%	12.20%	30.28%	39.85%	2.32%
Texas Northern Plains Feedgrain 8000	13.21%	11.36%	37.60%	33.73%	2.01%
Texas Uvalde Grain 1200	12.73%	9.85%	41.32%	29.64%	4.15%
Non-irrigated					
Texas Blacklands Grain 1600	5.61%	0.70%	52.35%	34.15%	4.24%
Texas Hill County Grain 2000	2.32%	0.63%	42.37%	48.95%	3.35%
Texas Northern Plains Feedgrain 8000	1.05%	0.13%	25.40%	69.32%	2.66%

Wheat farms

The AFPC wheat farms are located in Colorado, Kansas, Montana, Washington, and Oregon. The farms each have different crop mixes, but wheat is the main crop for all of them. As none of the farms irrigate wheat, results are reported for winter wheat and spring wheat.

The farm size, enterprise size, GHG emission per acre, and GHG emission per pound of wheat produced are given in table 4.7. The average GHG emission per pound of winter wheat, 0.789 pounds, is much lower than that of spring wheat, 1.097 pounds. Previous LCAs of wheat have estimated a range of values for CO_2 equivalent emissions. O'Donnell et al. estimated the CO_2 equivalent emission of several wheat varieties, ranging from 0.136 to 0.316 pounds per pounds wheat for winter wheat varieties and 0.202 to 0.272 pounds per pound of wheat for spring wheat (2009). Williams, Audsley, and Sandars estimate GHG emissions from wheat grown in England and Wales at 0.7 pounds of CO_2 equivalent per pound of wheat (2010). Their estimates are lower than the estimates in this study, but O'Donnell et al. omit emissions from soils and make different assumptions about pesticides, resulting in lower emissions from insecticides.

In each case where there are two farms in one location, the larger farm has lower GHG per pound of wheat. This suggests that larger wheat operations may be more carbon efficient.

Table 4.7 GHG Emission Summary for Wheat Farms

Farm Name	Farm size	Enterprise size (acres)	Per-acre CO_2 emission (lbs CO_2/acre)	GHG intensity (lbs CO_2 eq/lb wheat)
Winter Wheat				
Oregon Wheat 3600	3600	1440	1224	0.453
Central Kansas Wheat 4500	4500	2700	1620	0.600
Central Kansas Wheat 2000	2000	1200	1680	0.622
Washington Wheat 1725	1725	690	3406	0.668
Adams County Washington Wheat 3500	3500	1500	1604	0.668
Washington Wheat 5500	5500	1833	3533	0.693
Montana Wheat 4500	4500	2150	1874	0.726
Washington Colorado Wheat 5640	5640	2256	2264	0.755
Washington Colorado Wheat 3000	3000	970	1783	0.990
Northwest Kansas Wheat 4000	4000	1000	3908	1.184
Northwest Kansas Wheat 5500	5500	1000	4348	1.318
Mean			*2477*	*0.789*
Spring wheat				
Montana Wheat 4500	4500	180	1818	1.010
Oregon Wheat 3600	3600	160	1902	1.057
Washington Wheat 5500	5500	1222	4042	1.123
Washington Wheat 1725	1725	457	4320	1.200
Mean			*3021*	*1.097*

The relative contributions of the five source categories for wheat are given in table 4.8. Fuel, electricity and soils are relatively small drivers for emissions while fertilizers and pesticides represent large portions of per pound GHG emissions. This is consistent with both O’Donnell et al. and Williams, Audsley, and Sandars, as they found fuel’s share of emission to be relatively small and fertilizer’s to be large.

Table 4.8 Proportion of GHG Emission of Each Input Category to Entire Production Chain Emissions for Wheat Farms

Farm Name	Fuel	Electricity	Fertilizer	Pesticides	Soils
Winter Wheat					
Adams County Washington Wheat 3500	13.05%	1.06%	25.83%	50.70%	7.87%
Central Kansas Wheat 2000	8.95%	5.02%	48.43%	26.48%	8.46%
Central Kansas Wheat 4500	14.11%	2.31%	50.22%	21.82%	8.77%
Montana Wheat 4500	8.68%	2.46%	59.19%	19.14%	7.25%
Northwest Kansas Wheat 4000	4.05%	0.49%	36.15%	53.28%	3.99%
Northwest Kansas Wheat 5500	4.05%	0.49%	36.15%	53.28%	3.99%
Oregon Wheat 3600	16.36%	1.00%	33.86%	35.21%	11.61%
Washington Colorado Wheat 3000	3.81%	2.97%	32.46%	53.64%	5.31%
Washington Colorado Wheat 5640	2.95%	3.07%	23.82%	63.00%	5.84%
Washington Wheat 1725	5.12%	0.28%	40.19%	44.27%	7.88%
Washington Wheat 5500	6.92%	0.43%	32.43%	50.79%	7.60%
Spring wheat					
Montana Wheat 4500	8.94%	2.54%	61.01%	19.73%	4.41%
Oregon Wheat 3600	15.01%	0.92%	32.67%	45.30%	4.21%
Washington Wheat 1725	4.91%	0.27%	31.00%	58.36%	3.71%
Washington Wheat 5500	7.97%	0.50%	39.38%	45.96%	3.97%

Rice farms

Rice is grown in three major regions in the United States: California, Texas, and the Delta region of Arkansas, Mississippi, and Louisiana. All the rice grown on the representative farms is continuously flooded and there are two main ways to maintain the flood. Most of the representative rice farms use groundwater pumped with wells. Pumping groundwater requires fuel and electricity (a 50/50 mix is assumed in this study). Some farms, however, maintain their floods with surface irrigation. Surface irrigated farms use water delivered in a network of canals which are used to flood the fields. Surface irrigation has almost no associated fuel consumption. Apart from the irrigation criterion, the representative farms vary widely in their production systems. For instance, the rice growing region of Texas has low fertility soils. Also, ground water in

Arkansas and Louisiana is much closer to the surface than in Texas and California rice requires more pesticides. The presented CO_2 equivalent emission results are therefore grouped by state rather than by irrigation system.

Average pounds of CO_2 equivalent per pound of rice production in California, Texas, Louisiana, and Arkansas are 1.673, 1.656, 1.790, and 1.565, respectively (table 4.9). The one location with two farms, Sutter County, California, showed higher carbon intensity for the smaller farm. Average per-acre GHG emissions are higher for California and Texas at 14,729 and 14,632 pounds of CO_2 equivalent per acre, respectively, than for Louisiana and Arkansas at 12,107 and 11,116 pounds CO_2 equivalent per acre, respectively. Interestingly, farms with surface flood irrigation in California have higher GHG intensities and per-acre emissions than farms in Texas and Arkansas.

Life cycle assessments of rice grown in the U.S. are very limited. However, several have been conducted for rice grown in East Asia and Europe. For instance, Blengini and Busto (2009) estimated GHG emission of Italian rice at 2.9 pounds of CO_2 equivalent per pound of rice delivered to the store. Their estimate is higher than this study for several reasons. First, it is in a different region with different weather, yields, and cropping systems. Also, while this analysis stops at the farm gate, Blengini and Busto inventoried emissions from beyond the farm gate up to delivery to stores, including transportation and drying.

Table 4.9 GHG Emission Summary for Rice Farms

Farm name	Farm size (acres)	Enterprise size (acres)	Per-acre CO_2 emission (lbs CO_2 eq/acre)	GHG intensity (lbs CO_2 eq/lb rice)
California				
Colusa California Rice 800 SFI	800	800	14192	1.577
Sutter California Rice 3000 SFI	3000	3000	14565	1.618
Butte California Rice 1300 SFI	1300	1200	14968	1.730
Sutter California Rice 550 SFI	550	500	15190	1.766
Mean			*14729*	*1.673*
Texas				
Eagle Lake Rice Texas 3000 WI	3000	1200	13925	1.556
Eagle Lake Texas Rice 1350 WI	1350	450	13785	1.616
Bay City Texas Rice 1800 SFI	1800	600	16873	1.678
El Campo Rice Texas 3200 WI	3200	1067	13945	1.774
Mean			*14632*	*1.656*
Louisiana				
Acadia Louisiana Rice 1200 WI	1200	660	11060	1.701
Richland Louisiana Rice 2500 WI	2500	500	13153	1.879
Mean			*12107*	*1.790*
Arkansas				
Desha Arkansas Cotton and Rice 7500 WI	7500	1875	10988	1.436
Stuttgart Arkansas Rice 3240 WI	3240	1620	11183	1.603
Hoxie Arkansas Rice 3000 WI	3000	1300	11564	1.606
Wynne Arkansas Rice 1400 WI	1400	700	11615	1.636
Hoxie Arkansas Rice 3000 WI-medium grain	3000	150	11492	1.702
Butler Missouri Rice 4000 WI*	4000	2000	9857	1.408
Mean			*11116*	*1.565*

*Butler County, Missouri rice production is grouped with Arkansas because of the similarity of their production systems.
Note: “SFI” denotes surface flood irrigated. “WI” denotes well irrigated.

The California farm’s high carbon emissions result is explained by high pesticide use in table 4.10. Pesticides constitute a much larger percentage of total emissions for California farms than for other farms. Pesticides are particularly carbon intensive inputs. Texas, Louisiana, and Arkansas farms use more fuel and electricity than California farms, and soils make up a larger percentage of their total emission as well. California farms, compared to farms in other states, use less fuel and electricity, due to their surface flood irrigation. Bay City, Texas is an outlier among the Texas farms in the fuel category because it is the only farm in Texas using surface flood irrigation. Furthermore, fertilizers make up a larger portion of emissions from Texas farms than for farms in other states.

Table 4.10 Proportion of GHG Emission of Each Input Category to Entire Production Chain Emissions for Rice Farms

Farm name	Fuel	Electricity	Fertilizer	Pesticides	Soils
California					
Butte California Rice 1300 SFI	4.93%	0.22%	10.83%	66.72%	16.29%
Colusa California Rice 800 SFI	5.69%	0.22%	13.79%	61.81%	17.20%
Sutter California Rice 550 SFI	6.04%	0.25%	13.07%	63.38%	16.05%
Sutter California Rice 3000 SFI	4.20%	0.36%	13.15%	64.31%	16.76%
Texas					
Bay City Texas Rice 1800 SFI	2.99%	0.96%	25.05%	54.17%	14.52%
Eagle Lake Texas Rice 1350 WI	9.75%	6.20%	26.71%	37.23%	17.68%
Eagle Lake Texas Rice 3000 WI	9.03%	5.44%	28.17%	37.25%	17.53%
El Campo Texas Rice 3200 WI	12.20%	5.82%	25.39%	36.86%	17.44%
Louisiana					
Acadia Louisiana Rice 1200 WI	11.43%	6.13%	19.89%	38.84%	21.88%
Richland Louisiana Rice 2500 WI	8.36%	5.25%	17.85%	48.44%	18.43%
Arkansas					
Desha Arkansas Cotton and Rice 7500 WI	8.52%	5.47%	18.77%	35.91%	29.61%
Hoxie Arkansas Rice 3000 WI	8.57%	6.62%	23.44%	38.24%	21.08%
Hoxie Arkansas Rice 3000 WI	8.94%	6.74%	23.30%	38.00%	20.98%
Stuttgart Arkansas Rice 3240 WI	9.68%	6.57%	18.95%	41.45%	21.68%
Wynne Arkansas Rice 1400 WI	8.00%	5.66%	16.32%	47.70%	20.88%
Butler Missouri Rice 4000 WI*	8.52%	5.47%	18.77%	35.91%	29.61%

*Butler County, Missouri rice production is grouped with Arkansas because of the similarity of their production systems.

Cotton farms

In the United States, cotton is grown mainly in the Southeast, the Texas Southern Plains, and California. The crop mix varies with location, so emissions are reported only for the main crop, cotton. With cotton, irrigated and non-irrigated systems often occur on the same farm. Because they are on the same farm, the systems are essentially identical apart from irrigation and its direct effects on the system, which is beneficial to this study in that the effects of irrigation are more clearly seen. It should be noted that while cotton yields are normally reported in pounds of lint, the functional unit for this study is pounds of raw cotton. To approximate pounds of raw cotton, the seed yield from each enterprise is added back to the lint yield.

Average per-acre GHG emission for irrigated cotton, 11,121 pounds of CO_2 equivalent, is almost double that of non-irrigated cotton, 6,536 pounds of CO_2 equivalent (table 4.11). Per-acre GHG intensity is more than double in some individual cases, such as on the Texas Southern Plains 4500 farm. Average carbon dioxide equivalent emissions per pound of production are much lower for irrigated cotton farms with 3.868 pounds per pound of cotton compared to 4.087 for non-irrigated cotton. Irrigated cotton's lower average is explained by the large yield differential between irrigated and non-irrigated cotton. The irrigated and non-irrigated average emission suggests that the reduction in fuel consumption for non-irrigated farms is not sufficient to offset the reduction in yield for non-irrigated farms.

Table 4.11 GHG Emission Summary for Cotton Farms

Farm Name	Farm size (acres)	Enterprise size (acres)	Per-acre CO_2 emission (lbs CO_2 eq/acre)	GHG intensity (lbs CO_2 eq/lb cotton)
Irrigated				
Texas Rio Grande Valley Cotton 4500	4500	500	6657	2.361
Texas Eastern Caprock Cotton 5000	5000	2650	7017	2.973
California Cotton 4000	4000	666	13307	3.377
Texas Southern Plains Cotton 2500	2500	300	11008	3.551
Texas Southern Plains Cotton 4500	4500	510	13638	3.598
Texas Panhandle Cotton and Grain 1800	1800	200	10104	3.886
Northeast Arkansas Cotton 5000	5000	4750	10464	3.890
Alabama Cotton 3000	3000	87.5	8168	3.927
Louisiana Cotton 2640	2640	554	11339	3.965
California Cotton 4000-Pima	4000	667	14868	4.348
Southwest Georgia Cotton 2300	2300	1046.5	15758	6.677
Mean			*11121*	*3.868*
Non-irrigated				
Texas Rio Grande Valley Cotton 4500	4500	995	3973	2.838
Texas Coastal Bend Cotton and Grain 2250	2250	1000	5572	3.287
Tennessee Cotton 2100	2100	525	7085	3.414
North Carolina Cotton 1500	1500	225	9332	3.748
Texas Midcoast Cotton and Grain 1800	1800	600	7459	3.989
Tennessee Cotton 4050	4050	2025	8553	3.997
Texas Rolling Plains Cotton 2500	2500	1000	4136	4.055
Texas Southern Plains Cotton 4500	4500	2406	3246	4.189
Alabama Cotton 3000	3000	962.5	7894	4.290
Texas Eastern Caprock Cotton 5000	5000	1000	3299	4.340
Texas Southern Plains Cotton 2500	2500	1658	3679	4.380
Louisiana Cotton 2640	2640	370	10399	4.561
Northeast Arkansas Cotton 5000	5000	250	9438	4.890
Southwest Georgia Cotton 2300	2300	448.5	7437	5.238
Mean			*6536*	*4.087*

Electricity and fuel contribute a greater percentage of GHG emissions in irrigated cotton systems (table 4.12). Even so, the major GHG emitting categories for both irrigated and non-irrigated cotton are fertilizer and pesticides. Emissions from soils are relatively low, owing to the low residue nature of cotton. Among farms that grow both irrigated and non-irrigated cotton, pesticides have a larger share of the non-irrigated cotton emissions than their irrigated counterparts.

Table 4.12 Proportion of GHG Emission of Each Input Category to Entire Production Chain Emissions for Cotton Farms

Farm Name	Fuel	Electricity	Fertilizer	Pesticides	Soils
Irrigated					
Alabama Cotton 3000	5.63%	2.20%	33.39%	49.92%	2.03%
California Cotton 4000	13.65%	3.07%	12.52%	67.93%	2.16%
California Cotton 4000-Pima	12.32%	2.76%	11.20%	71.44%	1.67%
Louisiana Cotton 2640	7.97%	4.77%	17.77%	66.83%	1.69%
Northeast Arkansas Cotton 5000	4.12%	2.11%	29.00%	61.22%	1.92%
Southwest Georgia Cotton 2300	4.84%	2.50%	44.01%	35.66%	1.21%
Texas Eastern Caprock Cotton 5000	14.10%	5.75%	13.83%	63.11%	2.44%
Texas Panhandle Cotton and Grain 1800	12.75%	5.97%	19.56%	58.99%	1.65%
Texas Rio Grande Valley Cotton 4500	8.50%	0.42%	16.74%	70.83%	2.57%
Texas Southern Plains Cotton 2500	16.70%	7.13%	13.22%	60.49%	1.71%
Texas Southern Plains Cotton 4500	13.95%	5.61%	22.91%	54.56%	1.70%
Non-irrigated					
Alabama Cotton 3000	3.94%	1.04%	34.50%	51.59%	1.87%
Louisiana Cotton 2640	4.06%	1.15%	19.38%	72.87%	1.47%
North Carolina Cotton 1500	7.35%	0.92%	27.18%	57.25%	2.15%
Northeast Arkansas Cotton 5000	2.62%	0.54%	27.43%	66.36%	1.52%
Southwest Georgia Cotton 2300	4.27%	0.48%	26.29%	66.07%	1.54%
Tennessee Cotton 2100	4.37%	0.31%	30.97%	60.41%	2.24%
Tennessee Cotton 4050	2.17%	0.42%	23.84%	67.92%	1.93%
Texas Coastal Bend Cotton and Grain 2250	4.11%	0.47%	16.95%	75.21%	2.32%
Texas Eastern Caprock Cotton 5000	4.75%	0.33%	5.88%	87.05%	1.66%
Texas Midcoast Cotton and Grain 1800	4.93%	0.48%	18.02%	73.69%	1.92%
Texas Rio Grande Valley Cotton 4500	5.11%	0.25%	16.83%	74.71%	2.16%
Texas Rolling Plains Cotton 2500	12.51%	0.96%	14.01%	70.10%	1.66%
Texas Southern Plains Cotton 2500	4.79%	0.55%	18.34%	73.89%	1.40%
Texas Southern Plains Cotton 4500	4.57%	0.59%	17.58%	74.82%	1.45%

Dairy farms

At one time, dairy production was concentrated in a corridor extending from upstate New York to Minnesota. Recently, dairies have moved into new areas such as the Southwest and California, due mainly to urban expansion in these regions (Cross 2006). The representative dairies reflect that shift. All of the AFPC representative dairy farms grow at least some of their feed.

Several simplifying assumptions were made and applied to all dairy operations. First, emissions from manure spreading are counted in the inventories of the dairy's other crops. Since manure is attributed to the crops on which it is spread, only that portion spread on fed crops are counted in the dairy inventory. Also, emissions are not allocated between milk and culled meat. Therefore CO_2 equivalent emissions may be slightly overestimated. Lastly, emissions from fertilizer, pesticides, and soils are not omitted from the analysis, but are aggregated into a single contribution category, on-farm feeds.

Average CO_2 equivalent emission per pound of milk is 1.082 pounds (table 4.13). Rotz, Montes, and Chianese (2010) estimated pounds of CO_2 equivalent per pound of energy corrected milk (ECM) from large dairies (500 cows) to be 0.53 in Pennsylvania and 0.57 in California. Casey and Holden (2005) estimated the pounds of CO_2 equivalent per pound of milk produced in Ireland to be 1.46. Verge et al. estimate GHG emissions from Canadian dairies to be 1.0 pounds per pounds of milk (2007). This study's estimate is similar to the Canadian and Irish studies, and not far from Rotz, Montes, and Chianese, who use energy corrected milk, which affects the normalization.

Table 4.13 GHG Emission Summary for Dairy Farms Without Milk Hauling

Farm Name	Farm Size (head)	Enterprise Size (head)	Per-head CO_2 emission (lbs CO_2 eq/head)	GHG intensity (lbs CO_2 eq/lb milk)
California Dairy 1710	1710	250	20441	0.865
Central New York Dairy 110	110	850	20697	0.870
Central New York Dairy 550	550	400	23205	0.928
Central Texas Dairy 550	550	140	33804	1.746
Central Texas Dairy 1300	1300	500	33804	1.746
East Texas Dairy 400	400	1710	19138	1.126
East Texas Dairy 1000	1000	110	27573	1.266
Missouri Grazing Dairy 550	550	1000	15435	1.223
Nevada Dairy 500	500	1500	20283	0.867
North Florida Dairy 550	550	550	29568	1.616
North Texas Dairy 3000	3000	600	39008	1.799
South Florida Dairy 1500	1500	145	17772	0.921
Vermont Dairy 140	140	1200	16377	0.779
Vermont Dairy 400	400	400	17071	0.710
Washington Dairy 250	250	500	16529	0.667
Washington Dairy 850	850	1000	17380	0.680
Western New York Dairy 600	600	550	21163	0.929
Western New York Dairy 1200	1200	550	24273	1.040
Wisconsin Dairy 145	145	550	25150	0.996
Wisconsin Dairy 1000	1000	3000	22830	0.877
Mean			*23075*	*1.082*

The relative contributions of individual source categories for milk are given in table 4.14. For most dairies, emissions from enteric fermentation make the largest contribution to total GHG emissions. Emissions from fuel tend to be a larger percentage in the Northeast and Lakes States than in Texas and the West.

Table 4.14 Proportion of Each Input Category to Entire Production Chain Emissions for Dairy Farms Without Milk Hauling

Farm Name	Fuel	Electricity	Manure management	Enteric Fermentation	On-Farm Feeds	Off-Farm Feeds
California Dairy 1710	2.53%	2.34%	19.30%	37.75%	10.47%	27.61%
Central New York Dairy 110	10.78%	3.99%	19.31%	37.28%	23.76%	4.88%
Central New York Dairy 550	9.74%	3.00%	17.22%	33.25%	17.05%	19.73%
Central Texas Dairy 550	2.50%	5.56%	18.42%	22.83%	18.29%	32.41%
Central Texas Dairy 1300	2.50%	5.56%	18.42%	22.83%	18.29%	32.41%
East Texas Dairy 400	5.85%	5.30%	26.10%	40.32%	21.68%	0.75%
East Texas Dairy 1000	2.99%	11.23%	18.12%	27.98%	6.63%	33.05%
Missouri Grazing Dairy 550	1.69%	7.40%	30.36%	49.99%	3.51%	7.04%
Nevada Dairy 500	3.95%	4.85%	27.16%	38.04%	5.00%	20.99%
North Florida Dairy 550	5.76%	7.24%	21.15%	26.10%	13.42%	26.34%
North Texas Dairy 3000	1.86%	2.83%	13.20%	19.78%	0.72%	61.61%
South Florida Dairy 1500	4.33%	8.85%	21.90%	43.42%	13.67%	7.82%
Vermont Dairy 140	8.72%	0.03%	24.15%	47.11%	19.99%	0.00%
Vermont Dairy 400	8.83%	0.02%	22.66%	45.20%	23.29%	0.00%
Washington Dairy 250	4.31%	2.99%	24.22%	46.68%	12.53%	9.27%
Washington Dairy 850	7.50%	1.59%	22.43%	44.40%	12.79%	11.29%
Western New York Dairy 600	8.61%	3.11%	18.88%	36.46%	19.65%	13.29%
Western New York Dairy 1200	7.62%	2.35%	16.04%	31.79%	22.61%	19.60%
Wisconsin Dairy 145	7.71%	10.44%	16.10%	30.68%	28.75%	6.32%
Wisconsin Dairy 1000	7.05%	6.05%	18.42%	33.80%	25.30%	9.38%

The stated boundaries of this study are the farm gate, i.e., transportation of crops to the point of sale is omitted. However, as dairies generally ship large quantities of milk every day, reporting the GHG emission including the emission associated with hauling may be appropriate.

The GHG emission summary with the farm gate boundary relaxed to include emissions up to the point of delivery is given in table 4.15. Average emission per head increased slightly from 23,075 to 25,367 pounds per cow while average emission per pound of milk increased by approximately one third from 1.082 to 1.336 pounds per pound of milk.

Table 4.15 GHG Emission Summary for Dairy Farms, Milk Hauling Included

Farm Name	Farm Size (head)	Enterprise Size (head)	Per-head CO_2 emission (lbs CO_2 eq/head)	GHG intensity (lbs CO_2 eq/lb milk)
Washington Dairy 250	250	250	16529	0.667
Washington Dairy 850	850	850	17380	0.680
Vermont Dairy 400	400	400	17071	0.710
Vermont Dairy 140	140	140	16377	0.779
California Dairy 1710	1710	1710	20441	0.865
Nevada Dairy 500	500	500	20283	0.867
Central New York Dairy 110	110	110	20697	0.870
Wisconsin Dairy 1000	1000	1000	22830	0.877
South Florida Dairy 1500	1500	1500	17772	0.921
Central New York Dairy 550	550	550	23205	0.928
Western New York Dairy 600	600	600	21163	0.929
Wisconsin Dairy 145	145	145	25150	0.996
Western New York Dairy 1200	1200	1200	24273	1.040
East Texas Dairy 400	400	400	19138	1.126
Missouri Grazing Dairy 550	550	500	15435	1.223
East Texas Dairy 1000	1000	1000	27573	1.266
North Florida Dairy 550	550	550	29568	1.616
Central Texas Dairy 550	550	550	33804	1.746
Central Texas Dairy 1300	1300	550	33804	1.746
North Texas Dairy 3000	3000	3000	39008	1.799
Mean			*25367*	*1.336*

The relative contributions of each emission source category are given in table 4.16. The extra emissions from milk hauling are included in the fuels source category. Adding the emissions from hauling increases the percent contribution of fuels in every case.

Table 4.16 Proportion of Each Input Category to Entire Production Chain Emissions for Dairy Farms, Milk Hauling Included

Farm Name	Fuel	Electricity	Manure management	Enteric Fermentation	On-Farm Feeds	Off-Farm Feeds
California Dairy 1710	7.02%	2.24%	18.41%	36.01%	9.99%	26.34%
Central New York Dairy 110	15.77%	3.77%	18.23%	35.20%	22.43%	4.61%
Central New York Dairy 550	21.78%	2.60%	14.93%	28.82%	14.78%	17.10%
Central Texas Dairy 550	8.99%	5.19%	17.19%	21.31%	17.07%	30.25%
Central Texas Dairy 1300	7.97%	4.16%	13.03%	18.52%	11.92%	44.41%
East Texas Dairy 400	17.57%	4.64%	22.85%	35.30%	18.98%	0.66%
East Texas Dairy 1000	8.33%	10.61%	17.12%	26.45%	6.26%	31.23%
Missouri Grazing Dairy 550	9.17%	6.84%	28.05%	46.19%	3.25%	6.50%
Nevada Dairy 500	25.31%	3.78%	21.12%	29.58%	3.89%	16.33%
North Florida Dairy 550	11.71%	6.78%	19.82%	24.45%	12.57%	24.67%
North Texas Dairy 3000	9.36%	2.61%	12.19%	18.27%	0.66%	56.90%
South Florida Dairy 1500	15.46%	7.82%	19.35%	38.37%	12.08%	6.91%
Vermont Dairy 140	14.87%	0.03%	22.53%	43.94%	18.64%	0.00%
Vermont Dairy 400	14.47%	0.02%	21.26%	42.40%	21.85%	0.00%
Washington Dairy 250	18.26%	2.55%	20.69%	39.88%	10.71%	7.92%
Washington Dairy 850	12.85%	1.50%	21.14%	41.83%	12.05%	10.64%
Western New York Dairy 600	14.47%	2.91%	17.67%	34.12%	18.39%	12.44%
Western New York Dairy 1200	12.73%	2.22%	15.15%	30.03%	21.36%	18.51%
Wisconsin Dairy 145	10.87%	10.08%	15.55%	29.63%	27.77%	6.11%
Wisconsin Dairy 1000	10.38%	5.83%	17.76%	32.59%	24.40%	9.04%

Cow-calf operations

The cow-calf operations analyzed in this study require the most complicated allocation scheme of any other systems, owing to the nature of the herd. The cow-calf operations on these farms involve keeping a relatively constant herd size and selling calves every year. The time horizon for most other agricultural operations is one year. But while most calves are born and sold in one season, the average cull cow has been on the representative farm for eight years before being culled. Because the functional unit is pounds of live weight leaving the farm, emissions from adult herd feed, enteric fermentation and manure management (which are estimated only for adult cows due to lack of data) must be accounted for only when the adult cow leaves the farm, i.e. is culled. The cow-calf emission allocation process is detailed in the methodology. To summarize, only the portion of emissions attributable to cows, bulls, steers and heifers leaving the farm in the current year is counted.

Table 4.17 GHG Emission Summary for Cow-Calf Operations

Farm Name	Farm Size (head)	Enterprise size (head)	Per-head CO_2 emission (lbs CO_2 eq/head)	GHG intensity (lbs CO_2 eq/lb leaving farm)
Montana Cow-calf 500	500	500	3086	3.817
Nevada Cow-calf 700	700	700	3057	5.329
Central Missouri Cow-calf 400	400	400	6186	6.061
Florida Cow-calf 1155	1155	1155	2695	7.625
California Cow-calf 500	500	500	4541	7.813
Dade Missouri Cow-calf 250	250	250	13150	7.930
Texas Rolling Plains Cow-calf 500	500	500	5715	10.554
South Dakota Cow-calf 375	375	375	6967	10.887
New Mexico Cow-calf 240	240	240	2297	12.212
Southern Texas Cow-calf 200	200	200	7045	14.080
Colorado Cow-calf 250	250	250	7842	14.256
Wyoming Cow-calf 435	435	435	4824	15.772
Mean			*5617*	*9.695*

The summary of GHG emissions for the cow-calf operations is given in table 4.17. On average, one pound of live weight leaving the farm accounts for 9.695 pounds of CO_2 equivalent emissions. Average GHG emission per head of adult cattle in the herd is 5617 pounds of CO_2 equivalent emission per head. A similar study performed in Western Canada estimated a GHG intensity of 13.04 pounds of CO_2 equivalent per pound of live weight beef (Beauchemin et al. 2010). They assume the same life span as this study. However, they include the feed lot phase emissions, while that is beyond the scope of this study. They report that 80% of CO_2 equivalents are emitted in the cow-calf phase. Adjusting their estimate by .8 yields 10.43 pounds, which is similar to the result of this analysis.

Relative contributions of emission source categories vary widely between farms (table 4.18). Off-farm feeds consistently represent small contributions, while enteric fermentation is a large contribution. Manure management also represents a large portion of emissions. As natural pasture emissions are omitted (natural pastures are assumed to be at a soil organic carbon equilibrium), farms that rely heavily on grazing have lower percent emissions from feed.

Table 4.18 Proportion of Each Input Category to Entire Production Chain Emissions for Cow-Calf Operations

Farm Name	Fuel	Electricity	Manure management	Enteric Fermentation	Off-Farm Feeds	On-Farm Feeds
California Cow-calf 500	25.11%	3.10%	20.57%	47.09%	0.00%	0.00%
Central Missouri Cow-calf 400	2.85%	2.94%	12.87%	32.48%	0.01%	46.16%
Colorado Cow-calf 250	5.70%	5.68%	17.65%	40.62%	0.50%	26.14%
Dade Missouri Cow-calf 250	2.34%	1.36%	9.55%	26.88%	5.04%	52.85%
Florida Cow-calf 1155	9.66%	2.42%	10.08%	27.36%	0.15%	48.34%
Montana Cow-calf 500	16.01%	6.92%	18.68%	53.91%	0.00%	0.61%
Nevada Cow-calf 700	16.83%	2.85%	13.17%	38.25%	0.02%	26.16%
New Mexico Cow-calf 240	13.04%	7.26%	19.99%	53.37%	2.16%	0.00%
South Dakota Cow-calf 375	8.82%	0.06%	25.56%	54.13%	0.00%	6.04%
Southern Texas Cow-calf 200	4.22%	1.40%	17.83%	42.98%	0.00%	30.01%
Texas Rolling Plains Cow-calf 500	8.79%	3.79%	23.84%	58.84%	0.00%	0.00%
Wyoming Cow-calf 435	16.85%	15.90%	15.90%	42.01%	0.00%	6.01%

Table 4.19 gives the total per-farm GHG emission as well as the per-acre emission for the whole farm. The whole farm per-acre intensity includes set-aside acres (e.g. Conservation Reserve Program acres and pasture land). Often, CRP and pasture land have associated negative emission, so farms that include these in their rotations typically have lower GHG emissions than similar farms without set-aside land.

Table 4.19 Whole-farm GHG Emission Summary for 95 Representative U.S. Farms

Farm Name	Total CO_2 Equivalent (lbs)	Per-acre GHG Emission (lbs CO_2 eq/acre or head)
Grain		
Indiana Feedgrain 1000	4645860	4646
Indiana Feedgrain 2200	8520683	3873
Iowa Feedgrain 1350	4068561	3014
Iowa Feedgrain 3400	7719496	2270
Missouri Feedgrain 1850	10780111	5827
Missouri Feedgrain 2050	7410922	3615
Missouri Feedgrain 4000	15291651	3823
Nebraska Feedgrain 2400	14741152	6142
Nebraska Feedgrain 4300	16108453	3746
North Dakota Feedgrain 2500	6401427	2561
North Dakota Feedgrain 8000	21944234	2743
South Carolina Grain 1800	7781143	4323
South Carolina Grain 3500	13248524	3785
Tennessee Feedgrain 900	3343385	3715
Tennessee Feedgrain 2200	8147824	3704
Texas Blacklands Grain 1600	6391375	3995
Texas Hill County Grain 2000	9124790	4562
Texas Northern Plains Feedgrain 3000	25219673	8407
Texas Northern Plains Feedgrain 8000	69618585	8702
Texas Panhandle Grain 3760	39626626	10539
Texas Uvalde Grain 1200	8808886	7341
Mean		*4825*
Wheat		
Adams County Washington Wheat 3500	1618863	463
Central Kansas Wheat 2000	4497256	2249
Central Kansas Wheat 4500	8419883	1871
Montana Wheat 4500	4355766	968
Northwest Kansas Wheat 4000	8858457	2215
Northwest Kansas Wheat 5500	18757326	3410
Oregon Wheat 3600	1281756	356
Washington Colorado Wheat 3000	4718171	1573
Washington Colorado Wheat 5640	6550140	1161
Washington Wheat 1725	5869386	3403
Washington Wheat 5500	16595122	3017
Mean		*1880*
Rice		
Arkansas Cotton and Rice 7500	61117555	8149
Butte California Rice 1300	17961068	13816

Table 4.19 Continued

Farm Name	Total CO_2 Equivalent (lbs)	Per-acre GHG Emission (lbs CO_2 eq/acre or head)
Colusa California Rice 800	11353403	14192
Hoxie Arkansas Rice 3000	22736647	7579
Missouri Butler Rice 4000	23220299	5805
Northeast Louisiana Rice 2500	18479618	7392
Southern Louisiana Rice 1200	7921510	6601
Stuttgart Arkansas Rice 3240	21365600	6594
Sutter California Rice 550	7595045	13809
Sutter California Rice 3000	43695430	14565
Texas Bay City Rice 1800	10123818	5624
Texas Eagle Lake Rice 1350	6203350	4595
Texas Eagle Lake Rice 3000	16709974	5570
Texas El Campo Rice 3200	19517269	6099
Wynne Arkansas Rice 1400	10484617	7489
Mean		*8525*
Cotton		
Alabama Cotton 3000	17263096	5754
California Cotton 4000	50333086	12583
Louisiana Cotton 2640	20946154	7934
North Carolina Cotton 1500	8483515	5656
Northeast Arkansas Cotton 5000	52063198	10413
Southwest Georgia Cotton 2300	25012823	10875
Tennessee Cotton 2100	9638488	4590
Tennessee Cotton 4050	28138446	6948
Texas Coastal Bend Cotton and Grain 2250	9013793	4006
Texas Eastern Caprock Cotton 5000	22827319	4565
Texas Midcoast Cotton and Grain 1800	8919618	4955
Texas Panhandle Cotton and Grain 1800	16684238	9269
Texas Rio Grande Valley Cotton 4500	16044806	3566
Texas Rolling Plains Cotton 2500	4853929	1942
Texas Southern Plains Cotton 2500	10320036	4128
Texas Southern Plains Cotton 4500	15980720	3551
Mean		*6296*
Dairy with Hauling		
Missouri Grazing Dairy 550	9903639	18007
Vermont Dairy 140	2553748	18241
Washington Dairy 850	15858770	18657
Vermont Dairy 400	8426241	21066
South Florida Dairy 1500	32085124	21390
California Dairy 1710	38344142	22423
Central New York Dairy 110	2598031	23618
East Texas Dairy 400	9591404	23979
Western New York Dairy 600	14789408	24649
Wisconsin Dairy 1000	25371865	25372
Western New York Dairy 1200	31530774	26276
Nevada Dairy 500	13291178	26582
Central New York Dairy 550	15464782	28118
Wisconsin Dairy 145	4236523	29217
East Texas Dairy 1000	31087663	31088
North Florida Dairy 550	18697469	33995
Central Texas Dairy 1300	56037322	43106
Central Texas Dairy 550	23773543	43225
North Texas Dairy 3000	129778897	43260
Washington Dairy 250	15858770	63435
Mean		*29285*

Table 4.19 Continued

Farm Name	Total CO_2 Equivalent (lbs)	Per-acre GHG Emission (lbs CO_2 eq/acre or head)
Dairy without Hauling		
Missouri Grazing Dairy 550	9255825	16829
Washington Dairy 250	4248897	16996
Vermont Dairy 140	2385661	17040
Washington Dairy 850	14944861	17582
South Florida Dairy 1500	28540157	19027
Vermont Dairy 400	7975496	19939
Nevada Dairy 500	10380105	20760
East Texas Dairy 400	8470352	21176
California Dairy 1710	36626996	21419
Central New York Dairy 110	2463226	22393
Western New York Dairy 600	13910339	23184
Wisconsin Dairy 1000	24520655	24521
Central New York Dairy 550	13493743	24534
Western New York Dairy 1200	29808513	24840
Wisconsin Dairy 145	4107141	28325
East Texas Dairy 1000	29476666	29477
North Florida Dairy 550	17551334	31912
North Texas Dairy 3000	120009640	40003
Central Texas Dairy 1300	52421645	40324
Central Texas Dairy 550	22424381	40772
Mean		*25053*
Cow-calf		
California Cow-calf 500	2406929	4814
Central Missouri Cow-calf 400	2805944	7015
Colorado Cow-calf 250	2144303	8577
Dade Missouri Cow-calf 250	8833162	35333
Florida Cow-calf 1155	3243812	2808
Montana Cow-calf 500	1623013	3246
Nevada Cow-calf 700	2454884	3507
New Mexico Cow-calf 240	1699518	7081
South Dakota Cow-calf 375	2959148	7891
Southern Texas Cow-calf 200	2005708	10029
Texas Rolling Plains Cow-calf 500	3028732	6057
Wyoming Cow-calf 435	2235388	5139
Mean		*8458*

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

Agriculture as an industry is a major contributor to anthropogenic greenhouse gas emissions. Farms in the United States are no exception. Research in this vein has been conducted for farms in Europe and Asia, but few for farms in the Untied States. Most of these studies are either industry-wide or use aggregate input data from large, pre-made databases. They also often assume a monocrop system. A baseline measure of agricultural greenhouse gas emissions in the U.S., at the farm level and using individual, multicrop farm level data, is therefore necessary to inform agricultural and environmental decision makers of the environmental costs and benefits of agricultural production.

The objective of this research was to estimate farm level GHG emissions for multicrop farms in the United States and to highlight the major GHG emitting inputs in their supply chains. The analysis was done using the set of representative farms maintained by the Agricultural and Food Policy Center at Texas A&M University.

The objective of this research was met by applying a partial life cycle assessment methodology to 95 representative crop and livestock farms from across the United States. Life cycle assessment is a framework in which to quantify the emissions of a product or production chain at each of its stages, from mineral extraction to disposal or recycling, known as “cradle to grave.” It consists of four phases, goal and scope definition, life cycle inventory, life cycle impact assessment, and interpretation (ISO

2006a). The goal of this study was defined in the objective statement. The functional units were defined as pounds of CO_2 equivalent per acre or head in the enterprise, pounds of CO_2 equivalent per harvest unit (bushels, hundredweights, pounds, or tons), and pounds of CO_2 equivalent per pound of production. As for the scope, this study used a modified approach common to agricultural LCAs, in that the system upper bound was drawn at the farm gate, i.e., when the product leaves the farm. Carbon dioxide, methane, and nitrous oxide emissions were inventoried in every stage of production up to the farm gate for fuels, fertilizers, pesticides, electricity, soils, livestock processes, feeds, and manure management. In the impact assessment stage, the inventoried emissions were converted into CO_2 equivalents according to their global warming potentials relative to CO_2. They were normalized over the acres or number of head in the individual enterprises, as well as total yields in each crop's respective yield unit and in pounds. In the interpretation phase, GHG intensities were compared between farms growing the same crops and between regions growing the same crops. Also, the relative contributions of each GHG emitter category were compared between farms and regions.

The 21 grain farms were compared according to their corn, soybean, and grain sorghum crops. Per-acre emissions were higher on average for irrigated corn than non-irrigated at 9,408 and 5,623 pounds per acre, respectively. Emissions per pound of irrigated and non-irrigated corn were 0.901 and 0.664 pounds, respectively. GHG intensity was higher for irrigated corn in both instances. Average per-pound production emissions for soybeans are 0.376 pounds for irrigated and 0.537 pounds for non-irrigated. Irrigated soybeans are less GHG intensive on a per-pound basis because emission per acre is almost equal for irrigated and non-irrigated soybeans, but non-irrigated soybeans have lower yields. The effect of farm size was ambiguous for soybeans, as smaller farms in the East had lower GHG intensities relative to larger farms in the same locations. However, in the major grain-producing states, the effect of was size was similar to the effect of size in the corn crops. Of the representative grain farms, only those in Texas grow grain sorghum. The average GHG emission for sorghum is 0.967 pounds CO_2 equivalent per pound of irrigated sorghum and 0.751 pounds CO_2 equivalent per pound of non-irrigated sorghum. Except with regards to soybeans, larger farms tended to be less GHG intensive than smaller farms in the same location. Fertilizer, fuel, and pesticides were the major GHG contributors for corn, soybeans, and grain sorghum.

The 11 wheat farms were divided by variety, rather than irrigation practice. The average GHG emission per pound of winter wheat was 0.789 pounds, and for spring wheat, 1.097 pounds. In each case where there are two farms in one location, the larger farm is less GHG intensive per pound of wheat. This suggests that larger wheat operations may be more carbon efficient. Fertilizer and pesticides were the major contributors to GHG emission for both winter and spring wheat.

The 15 rice farms were divided by state because of the diversity of cropping systems used in the United States. Average pounds of CO_2 equivalent per pound of rice is 1.673 for California, 1.656 for Texas, 1.790 for Louisiana, and 1.565 for Arkansas. The two farms in Sutter County, California showed higher carbon intensity for the smaller farm. Average per-acre GHG emissions are 14,729 pounds for California and

14,632 pounds for Texas Emissions from farms in Louisiana and Arkansas are 12,107 and 11,116 pounds CO_2 equivalent per acre, respectively. Because of large variations in pest management, soil fertility and water availability, no conclusive statements can be made regarding farm size and GHG intensity. Farms in California have higher contributions from pesticides than farms in other states, and farms in Texas have higher contributions from fertilizer than farms in other states.

Results for the 16 cotton farms are also categorized by irrigation practice. Average CO_2 equivalent emissions per pound of production are 3.868 pounds for irrigated cotton and 4.087 pounds for non-irrigated cotton. Irrigated cotton is less GHG intensive because non-irrigated cotton has much smaller yields than irrigated cotton. These numbers suggest that reduced fuel consumption on non-irrigated farms does not offset the lower yields of non-irrigated cotton. While fuel and electricity have larger contributions to GHG emissions in irrigated cotton, fertilizer and pesticides are the major emitters for both irrigated and non-irrigated cotton.

For the 20 dairies analyzed, average CO_2 equivalent emission of milk is 1.081 pounds per pound. For the majority of the dairies, enteric fermentation contributes the most to GHG emissions from the farm. Also, fuels are larger relative emitters in the Northeastern and Lakes States than in Texas and the Western States.

For the 12 cow-calf operations, one pound of live weight leaving the farm accounts for 9.695 pounds of CO_2 equivalent emissions, on average. Emissions per-head of adult cattle in the herd average 5617 pounds of CO_2 equivalent. While relative contributions of emission source categories differ between farms, enteric fermentation is consistently a large contributor. Off-farm feed contributions are small. Manure management is also an important contributor. Grazing operations have lower emissions from feed because emissions from natural pasture are not included.

Conclusions

Overall, this analysis shows that the GHG intensity of U.S. multicrop farms is sensitive to three things: the location, size, and irrigation practices of the farm. When crops are grown in different regions, they have different GHG intensities because of differences in soil quality, weather, yields, and production efficiency. The same crops grown on farms of different sizes tend to be less GHG intensive on the larger farms. Furthermore, crops grown outside their associated regions (e.g., corn grown outside the Corn Belt) are often more GHG intensive than the same crops grown in their principle growing regions. The results of this study combine to suggest that there is a correlation between production efficiency and GHG efficiency. This relationship should be further investigated in future research.

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APPENDIX A

FULL GREENHOUSE GAS EMISSION SUMMARY TABLES

Table A-1 Greenhouse Gas Emission Summary for Grain Farms, by Farm and Crop

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
Indiana Feedgrain 1000	1000	HAC	Corn	Full till --> full till	500	3528944	7058	38.151	0.681
			Soybean	Full till --> full till	500	1116916	2234	42.148	0.702
Indiana Feedgrain 2200	2200	HAC	Corn	Full till --> full till	1100	6587276	5988	35.226	0.629
			Soybean	Full till --> full till	1100	1933407	1758	29.294	0.488
Iowa Feedgrain 1350	1350	HAC	Corn	Reduced till --> no till	880	3492324	3969	22.047	0.394
			Soybean	Reduced till --> no till	470	576237	1226	23.578	0.393

Table A-1 Continued

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
Iowa Feedgrain 3400	3400	HAC	Corn	Reduced till --> no till	2040	6395461	3135	16.946	0.303
			Soybean	Reduced till --> no till	1360	1324035	974	19.471	0.325
Missouri Feedgrain 1850	1850	HAC	Corn	Full till --> full till	900	6470452	7339	50.616	0.904
			Soybean	Full till --> full till	900	1521316	1690	37.563	0.626
			Pasture	No till --> no till	800	704826	881	881.033	0.441
			Alfalfa establishment	No till --> no till	30	25179	839	419.652	0.210
			Alfalfa	No till --> no till	170	16572	552	110.477	0.055
			Cow-calf		200	2041766	9816	1321.531	13.215
Missouri Feedgrain 2050	2050	HAC	Corn	Full till --> full till	1025	6096244	5948	36.046	0.644
			Soybean	Full till --> full till	1025	1314678	1283	23.320	0.389

Table A-1 Continued

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
			Soybean	Full till --> full till	1800	2568255	1427	26.921	0.449
Nebraska Feedgrain 2400	2400	HAC	Irrigated corn	Full till --> reduced till	900	6888143	7653	38.267	0.683
			Irrigated food grade corn	Full till --> reduced till	900	6888143	7653	38.267	0.683
			Irrigated soybean	Full till --> reduced till	600	964866	1608	24.740	0.412
Nebraska Feedgrain 4300	4300	HAC	Irrigated corn	Full till --> reduced till	1935	10575677	5465	27.327	0.488
			Irrigated food grade corn	Full till --> reduced till	645	3796777	5886	30.579	0.546
			Irrigated soybean	Full till --> reduced till	1290	1575942	1222	20.361	0.339
			Alfalfa establishment	Reduced till --> reduced till	72	102391	1422	270.876	0.135
			Alfalfa	No till --> no till	358	57666	913	173.861	0.087
North Dakota Feedgrain 2500	2500	HAC	Winter wheat	Reduced till --> no till	500	1793693	3587	59.790	0.996

Table A-1 Continued

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
			Corn	Full till--> full till	500	2606324	5213	41.701	0.745
			Soybean	Full till --> full till	1500	1995189	1330	41.566	0.693
			CRP	No till --> no till	100	6221	62	62.207	0.031
North Dakota Feedgrain 8000	8000	HAC	Winter wheat	Reduced till --> no till	1000	4041740	4042	57.739	0.962
			Sunflowers	Reduced till --> no till	300	1297092	4324	254.332	4.239
			Soybean	Full till --> full till	4000	5316490	1329	37.975	0.678
			CRP	No till --> no till	250	12281	49	49.125	0.025
			Corn	Full till --> full till	2450	11276629	4603	40.024	0.715
South Carolina Grain 1800	1800	LAC	Corn	Full till --> reduced till	525	2206166	4202	52.528	0.938
			Winter wheat	Reduced till --> no till	75	200130	2668	66.710	1.112
			Soybean	Full till --> reduced till	75	50824	678	22.588	0.376

Table A-1 Continued

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
			Cotton	Full till --> reduced till	300	1835609	6119	3.516	3.516
			Irrigated cotton	Full till->reduced till	225	1445920	6426	2.571	2.571
			Irrigated Virginia peanut	Full till --> reduced till	250	1374073	5496	3664.196	1.832
			Runner peanut	Full till --> reduced till	125	668420	5347	3564.908	1.782
South Carolina Grain 3500	3500	LAC	Corn	Full till --> reduced till	2100	9631156	4586	40.949	0.731
			Soybean	Full till --> reduced till	700	833937	1191	34.038	0.567
			Double crop soybeans	Full till --> reduced till	700	850368	1215	37.963	0.633
			Winter wheat	Reduced till --> no till	700	1933063	2762	48.730	0.812
Tennessee Feedgrain 900	900	HAC	Corn	Reduced till --> no till	400	2057899	5145	35.481	0.634
			Winter wheat	Reduced till --> no till	100	279321	2793	49.004	0.817
			Soybean	Reduced till --> no till	400	516792	1292	26.916	0.449

Table A-1 Continued

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
			White corn	Reduced till --> no till	100	489374	4894	36.250	0.647
Tennessee Feedgrain 2200	2200	HAC	Corn	Full till --> full till	1100	5599742	5091	35.108	0.627
			Winter wheat	Full till --> full till	300	835353	2785	48.851	0.814
			Soybean	Full till --> full till	800	1346348	1683	33.659	0.561
			Double crop soybean	Full till --> full till	300	366381	1221	24.425	0.407
Texas Blacklands Grain 1600	1600	HAC	Sorghum	Full till --> full till	300	1267215	4224	59.160	0.592
			Cotton	Full till --> full till	200	1184725	5924	3.897	3.897
			Winter wheat	Full till --> full till	100	193353	1934	55.244	0.921
			Corn	Full till --> full till	1000	3601965	3602	42.376	0.757
			Cow-calf		50	144117	2771	587.034	5.870
Texas Hill County Grain 2000	2000	HAC	Sorghum	Full till --> full till	500	2510091	5020	74.928	0.749

Table A-1 Continued

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
			Cotton	Full till --> full till	250	2085119	8340	5.713	5.713
			Winter wheat	Reduced till --> no till	250	712077	2848	81.380	1.356
			Corn	Reduced till --> no till	1000	3331999	3332	37.022	0.661
			Cow-calf		40	485504	11560	2182.039	21.820
Texas Northern Plains Feedgrain 3000	3000	HAC	Irrigated winter wheat	Reduced till --> no till	720	3711420	5155	81.821	1.364
			Irrigated sorghum	Reduced till --> no till	240	2286090	9525	107.027	1.070
			Irrigated corn	Full till --> reduced till	960	13154173	13702	62.283	1.112
			Irrigated cotton	Full till --> reduced till	480	4881555	10170	2.897	2.897
			Cotton	Full till --> reduced till	150	692912	4619	4.666	4.666
			Winter wheat	Reduced till --> no till	150	493525	3290	219.344	3.656

Table A-1 Continued

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
Texas Northern Plains Feedgrain 8000	8000	HAC	Irrigated winter wheat	Reduced till --> no till	968	3351576	3462	54.958	0.916
			Irrigated sorghum	Full till --> reduced till	280	3078460	10994	123.534	1.235
			Irrigated corn	Full till --> reduced till	3120	42529780	13631	61.961	1.106
			Winter wheat	Reduced till --> no till	587	35538	61	3.027	0.050
			Sorghum	Full till --> reduced till	587	1621815	2763	91.184	0.912
			Irrigated cotton	Full till --> reduced till	1872	19001416	10150	3.274	3.274
Texas Panhandle Grain 3760	3760	HAC	Irrigated corn	Full till --> full till	1252	16044195	12815	51.259	0.915
			Irrigated white corn	Full till --> full till	626	8158662	13033	54.304	0.970
			Irrigated cotton	Full till --> full till	564	7532350	13355	4.350	4.350
			Irrigated winter wheat	Full till --> full till	800	1356576	1696		
			Winter wheat	Full till --> full till	564	-215173	-382		

Table A-1 Continued

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
			Irrigated corn silage	Full till --> full till	564	6750015	11968	374.003	0.187
Texas Uvalde Grain 1200	1200	HAC	Irrigated corn	Full till --> reduced till	500	4226697	8453	93.927	1.677
			Irrigated cotton	Full till --> reduced till	300	3039553	10132	3.176	3.176
			Irrigated sorghum	Full till --> reduced till	250	1542636	6171	59.504	0.595

Table A-2 GHG Emission Summary for Wheat Farms, by Farm and Crop

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
Adams County Washington Wheat 3500	3500	HAC	Winter wheat	Full till --> full till	1500	2406533	1604	40.109	0.668
			CRP	Full till --> no till	500	-787671	-1575	-1575.341	-0.788
Central Kansas Wheat 2000	2000	HAC	Winter wheat	Full till --> full till	1200	2015673	1680	37.327	0.622
			Corn	Full till --> full till	200	828967	4145	41.448	0.740
			Sorghum	Full till --> full till	200	641398	3207	42.760	0.428
			Soybean	Full till --> full till	400	1011219	2528	84.268	1.404
Central Kansas Wheat 4500	4500	HAC	Winter wheat	Full till --> full till	2700	4373402	1620	35.995	0.600
			Corn	Full till --> full till	675	2181991	3233	32.326	0.577
			Sorghum	Full till --> full till	450	1302024	2893	36.167	0.362
			Soybean	Full till --> full till	675	562466	833	41.664	0.694
Montana Wheat 4500	4500	HAC	Winter wheat	Full till --> full till	2150	4028509	1874	43.575	0.726
			Spring wheat	Full till --> full till	180	327256	1818	60.603	1.010

Table A-2 Continued

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
Northwest Kansas Wheat 4000	4000	HAC	Winter wheat	Reduced till --> no till	1000	3908190	3908	71.058	1.184
			CWinter wheat	Reduced till --> no till	500	1257207	2514	55.876	0.931
			Sorghum	Reduced till --> no till	500	1554436	3109	38.861	0.389
			Corn	Reduced till --> no till	1000	1860124	1860	15.501	0.277
			Cow-calf		80	278500	3355	582.636	5.826
Northwest Kansas Wheat 5500	5500	HAC	Winter wheat	Full till --> full till	1000	3,850,407	3,850	74.05	1.234
			CWinter wheat	Full till --> full till	820	2,761,984	3,368	70.17	1.170
			Sorghum	Full till --> full till	500	2,755,254	5,511	61.23	0.612
			Corn	Full till --> full till	1800	7,356,198	4,087	30.27	0.541
			Irrigated corn	Full till --> full till	250	1,266,127	5,065	22.02	0.393
			Soybeans	Full till --> full till	130	270,506	2,081	34.68	0.578
			Cow-calf		100	496,851	4,777	684.84	6.848
Oregon Wheat 3600	3600	HAC	Winter wheat	Full till --> full till	1440	1762079	1224	27.193	0.453
			Spring wheat	Full till --> full till	160	304357	1902	63.408	1.057
			CRP	Full till --> no till	400	-784679	-1962	-1961.699	

Table A-2 Continued

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
Washington Colorado Wheat 3000	3000	HAC	Winter wheat	Full till --> full till	970	1729221	1783	59.423	0.990
			Millet	Full till --> full till	805	1765189	2193	109.639	1.096
			Corn	Full till --> full till	600	1696858	2828	51.420	0.918
			CRP	Full till --> no till	300	-473097	-1577	-1576.991	-0.788
Washington Colorado Wheat 5640	5640	HAC	Winter wheat	Reduced till --> no till	2256	5108600	2264	45.289	0.755
			Millet	Reduced till --> no till	490	766795	1565	78.244	0.782
			Corn	Reduced till --> no till	490	1302279	2658	53.154	0.949
			CRP	Reduced till --> no till	430	-627534	-1459	-1459.380	-0.730
Washington Wheat 1725	1725	HAC	Winter wheat	Full till --> full till	690	2349835	3406	40.065	0.668
			Barley	Full till --> full till	120	366333	3053	41.819	0.871
			Peas	Full till --> full till	458	1178767	2574	128.686	1.287
			Spring wheat	Full till --> full till	457	1974452	4320	72.008	1.200
Washington Wheat 5500	5500	HAC	Winter wheat	Full till --> full till	1833	6475274	3533	41.560	0.693
			Barley	Full till --> full till	611	2033513	3328	45.591	0.950

Table A-2 Continued

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
			Peas and lentils	Full till --> full till	1204	3188436	2648	132.410	1.324
			Spring wheat	Full till --> full till	1222	4939768	4042	67.373	1.123
			CRP	Full till --> no till	360	-41868	-116	-116.301	-0.058

Table A-3 GHG Emission Summary for Rice Farms, by Farm and Crop

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
Arkansas Cotton and Rice 7500	7500	HAC	Irrigated flooded rice		1875	20603222	10988	143.639	1.436
			Irrigated soybean	Full till --> full till	1625	5933749	3652	73.031	1.217
			Irrigated double crop soybean	Full till --> full till	750	1863918	2485	71.006	1.183
			Irrigated corn	Full till --> full till	1500	12512072	8341	46.341	0.828
			Winter wheat	Full till --> full till	1000	3585442	3585	59.757	0.996
			Irrigated cotton	Full till --> full till	1500	16619151	11079	3.121	3.121
Butte California Rice 1300	1300	HAC	Flooded rice		1200	17961068	14968	173.035	1.730
Colusa California Rice 800	800	HAC	Flooded rice		800	11353403	14192	157.686	1.577
Hoxie Arkansas Rice 3000	3000	HAC	Irrigated medium grain flooded rice		150	1723735	11492	170.245	1.702
			Irrigated long grain flooded rice		1300	15032694	11564	160.606	1.606
			Irrigated soybean	Full till --> full till	1125	3305812	2938	65.300	1.088
			Soybean	Full till --> full till	125	317585	2541	115.486	1.925
			Irrigated corn	Full till --> full till	300	2356821	7856	47.613	0.850

Table A-3 Continued

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
Missouri Butler Rice 4000	4000	HAC	Irrigated flooded rice		2000	19713889	9857	140.813	1.408
			Irrigated soybean	Full till --> full till	2000	3506409	1753	37.302	0.622
Northeast Louisiana Rice 2500	2500	HAC	Irrigated flooded rice		500	6576664	13153	187.905	1.879
			Soybean	Full till --> full till	200	456825	2284	81.576	1.360
			Irrigated soybean	Full till --> full till	600	1710220	2850	63.341	1.056
			Irrigated cotton	Full till --> full till	125	1523461	12188	3.881	3.881
			Cotton	Full till --> full till	125	1491081	11929	5.232	5.232
			Corn	Full till --> full till	162.5	1076302	6623	45.679	0.816
			Irrigated corn	Full till --> full till	787.5	5645066	7168	40.962	0.731
Southern Louisiana Rice 1200	1200	HAC	Irrigated flooded rice		660	7299394	11060	170.149	1.701
			Soybean	Full till --> full till	250	483121	1932	60.390	1.007
			Irrigated crawfish		150	138995	927	2.317	0.039

Table A-3 Continued

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
Stuttgart Arkansas Rice 3240	3240	HAC	Irrigated flooded rice		1620	18115658	11183	160.323	1.603
			Irrigated winter wheat	Reduced till --> no till	324	962643	2971	49.519	0.825
			Irrigated soybean	Full till --> full till	1296	1861544	1436	37.799	0.630
			Irrigated double crop soybean	Full till --> full till	324	425754	1314	46.931	0.782
Sutter California Rice 550	550	HAC	Flooded rice		500	7595045	15190	176.629	1.766
Sutter California Rice 3000	3000	HAC	Flooded rice		3000	43695430	14565	161.835	1.618
Texas Bay City Rice 1800	1800	HAC	Flooded rice		600	10123818	16873	167.757	1.678
Texas Eagle Lake Rice 1350	1350	HAC	Irrigated flooded rice		450	6203350	13785	161.609	1.616

Table A-3 Continued

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
Texas Eagle Lake Rice 3000	3000	HAC	Irrigated flooded rice		1200	16709974	13925	155.586	1.556
Texas El Campo Rice 3200	3200	HAC	Irrigated flooded rice		1067	14878989	13945	177.413	1.774
			Sorghum	Full till --> full till	640	3275913	5119	63.664	0.637
			Soybean	Full till --> full till	427	1362368	3191	93.840	1.564
Wynne Arkansas Rice 1400	1400	HAC	Irrigated flooded rice		700	8130724	11615	163.596	1.636
			Irrigated soybean		650	2213855	3406	75.687	1.261
			Soybean		50	140038	2801	80.021	1.334

Table A-4 GHG Emission Summary for Rice Farms, by Farm and Crop

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
Alabama Cotton 3000	3000	LAC	Irrigated cotton	Reduced till --> No till	87.5	714,670	8,168	3.93	3.927
			Cotton	Reduced till --> No till	962.5	7,597,603	7,894	4.29	4.290
			Corn	Reduced till --> No till	1262.5	6,772,025	5,364	44.70	0.798
			Irrigated corn	Reduced till --> No till	87.5	530,001	6,057	31.88	0.569
			Soybean	Reduced till --> No till	150.0	348,837	2,326	43.88	0.731
			Dry bean	Reduced till --> No till	450.0	9,187	2,042	81.66	1.361
			Winter wheat	Reduced till --> No till	450.0	1,290,774	2,868	39.84	0.664
California Cotton 4000	4000	HAC	Irrigated cotton	Full till --> full till	666.0	8,862,532	13,307	3.38	3.377
			Irrigated Pima cotton	Full till --> full till	667.0	9,917,260	14,868	4.35	4.348
			Irrigated wheat silage	Full till --> reduced till	1333.0	5,242,729	3,933	218.50	0.109
			Irrigated corn silage	Full till --> full till	1333.0	7,411,525	5,560	202.18	0.101
			Irrigated alfalfa establishment	Full till --> full till	67.0	495,523	7,396	1056.55	0.528
			Irrigated alfalfa	Full till --> reduced till	200.0	1,295,775	6,479	809.86	0.405
			Irrigated almond	Reduced till --> full till	400.0	13,978,630	34,947	12.48	12.481
			Irrigated winter wheat	Full till --> full till	667.0	3,129,112	4,691	44.68	0.745
Louisiana Cotton 2640	2640	HAC	Irrigated cotton	Full till --> full till	554.0	6,282,045	11,339	3.96	3.965
			Cotton	Full till --> full till	370.0	3,847,481	10,399	4.56	4.561
			Irrigated soybean	Full till --> full till	660.0	1,864,584	2,825	62.78	1.046

Table A-4 Continued

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
			Irrigated corn	Full till --> full till	633.0	5,549,315	8,767	50.10	0.895
			Corn	Full till --> full till	423.0	3,402,729	8,044	57.46	1.026
North Carolina Cotton 1500	1500	LAC	Cotton	Full till --> full till	225.0	2,099,704	9,332	3.75	3.748
			Soybean	Full till --> full till	850.0	3,646,308	4,290	85.80	1.430
			Winter wheat	Full till --> full till	255.0	1,044,949	4,098	68.30	1.138
			Corn	Full till --> full till	275.0	1,692,554	6,155	43.96	0.785
Northeast Arkansas Cotton 5000	5000	HAC	Irrigated cotton	Full till --> full till	4750.0	49,703,762	10,464	3.89	3.890
			Cotton	Full till --> full till	250.0	2,359,436	9,438	4.89	4.890
Southwest Georgia Cotton 2300	2300	LAC	Irrigated cotton	Full till --> full till	1046.5	16,490,925	15,758	6.68	6.677
			Cotton	Full till --> full till	448.5	3,335,676	7,437	5.24	5.238
			Corn	Full till --> full till	230.0	1,530,916	6,656	36.98	0.660
			Irrigated peanut	Full till --> full till	402.5	2,743,555	6,816	3170.37	1.585
			Peanut	Full till --> full till	172.5	911,752	5,286	3303.45	1.652
Tennessee Cotton 2100	2100	HAC	Cotton	Reduced till --> No till	525.0	3,719,569	7,085	3.41	3.414
			Soybean	Reduced till --> No till	1020.0	2,619,510	2,568	53.50	0.892
			Corn	Reduced till --> No till	525.0	3,337,575	6,357	39.73	0.710
			CRP	No till --> no till	30.0	(38,166)	(1,272)	-1272.20	-0.636
Tennessee Cotton 4050	4050	HAC	Cotton	Reduced till --> No till	2025.0	17,319,933	8,553	4.00	3.997
			Soybean	Reduced till --> No till	950.0	4,558,682	4,799	99.97	1.666

Table A-4 Continued

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
			Winter wheat	Reduced till --> No till	475.0	2,093,651	4,408	67.81	1.130
			Soybean	Reduced till --> No till	475.0	450,713	949	27.11	0.452
Texas Coastal Bend Cotton and Grain 2250	2250	HAC	Sorghum	Full till --> full till	1125.0	3,218,523	2,861	40.05	0.401
			Cotton	Full till --> full till	1000.0	5,571,778	5,572	3.29	3.287
			Corn	Full till --> full till	125.0	223,492	1,788	27.51	0.491
Texas Eastern Caprock Cotton 5000	5000	HAC	Cotton	Full till --> full till	1000.0	3,298,672	3,299	4.34	4.340
			Irrigated cotton	Full till --> full till	2650.0	18,593,923	7,017	2.97	2.973
			Irrigated sorghum	Full till --> full till	250.0	658,139	2,633	36.87	0.369
			Winter wheat	Full till --> full till	300.0	21,247	71	4.72	0.079
			Sorghum	Full till --> full till	300.0	255,337	851	19.08	0.191
Texas Midcoast Cotton and Grain 1800	1800	HAC	Sorghum	Full till --> full till	620.0	2,136,834	3,447	40.22	0.402
			Cotton	Full till --> full till	600.0	4,475,333	7,459	3.99	3.989
			Corn	Full till --> full till	480.0	1,975,592	4,116	37.42	0.668
			Soybean	Full till --> full till	100.0	331,859	3,319	118.52	1.975
Texas Panhandle Cotton and Grain 1800	1800	HAC	Irrigated corn	Reduced till --> No till	875.0	10,952,667	12,517	62.59	1.118

Table A-4 Continued

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
			Irrigated cotton	Reduced till --> No till	200.0	2,020,701	10,104	3.89	3.886
			Winter wheat	Reduced till --> No till	367.0	(7,340)	(20)	-1.18	-0.020
			Irrigated winter wheat	Reduced till --> No till	875.0	3,422,238	3,911	65.19	1.086
Texas Rio Grande Valley Cotton 4500	4500	HAC	Sorghum	Full till --> full till	2780.0	7,223,001	2,598	37.12	0.371
			Irrigated cotton	Full till --> full till	500.0	3,328,441	6,657	2.36	2.361
			Cotton	Full till --> full till	995	3,953,239	3,973	2.84	2.838
			Sugar cane	Full till --> full till	225.0	1,540,125	6,845	162.98	0.081
Texas Rolling Plains Cotton 2500	2500	HAC	Cotton	Full till --> full till	1000.0	4,136,030	4,136	4.05	4.055
			Winter wheat	Reduced till --> No till	1000.0	717,899	718		
			Pasture	No till --> no till	500.0	-	-		
Texas Southern Plains Cotton 2500	2500	HAC	Cotton	Full till --> full till	1658.0	6,099,794	3,679	4.38	4.380
			Irrigated cotton	Full till --> full till	300.0	3,302,318	11,008	3.55	3.551
			Irrigated peanut	Full till --> full till	50.0	275,207	5,504	2752.07	1.376

Table A-4 Continued

Farm name	Farm size	Soil Type	Crop	Tillage practice	Acres in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
			Irrigated sorghum	Full till --> full till	30.0	128,750	4,292	48.06	0.481
			Sorghum	Full till --> full till	160.0	156,486	978	36.49	0.365
Texas Southern Plains Cotton 4500	4500	HAC	Cotton	Full till --> full till	2406.0	7,810,856	3,246	4.19	4.189
			Irrigated cotton	Full till --> full till	510.0	6,955,307	13,638	3.60	3.598
			Irrigated peanut	Full till --> full till	120.0	974,603	8,122	3248.68	1.624
			CRP	Reduced till --> no till	288.0	(357,276)	(1,241)	-1240.54	-0.620
			Irrigated winter wheat	Full till --> full till	120.0	597,230	4,977	76.57	1.276

Table A-5 GHG Emission Summary for Dairy Farms, by Farm and Crop

Farm name	Farm size (head)	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
California Dairy 1710	1710	HAC	Irrigated corn silage	Full till -->full till	500	328664	4878	207.555	0.104
			Irrigated winter wheat	Reduced till --> no till	500	731387	2185	156.046	0.078
			Dairy w/hauling		1710	37284092	21428	90.641	0.906
			Dairy w/out hauling		1710	35566945	20441	86.466	0.865
Central New York Dairy 110	110	HAC	Ground corn	Full till -->full till	90	158984	4166	1144.592	0.572
			Haylage	No till --> no till	125	13269	519	74.163	0.037
			Grass hay	No till --> no till	30	14257	1228	307.125	0.154
			Dairy w/hauling		110	2411521	21923	92.155	0.922
			Dairy w/out hauling		110	2276716	20697	87.004	0.870
Central New York Dairy 550	550	HAC	Corn	Full till -->full till	475	420120	3913	195.670	0.098
			Alfalfa	No till --> no till	380	264429	1170	146.312	0.073
			Dairy w/hauling		550	14780233	26776	107.081	1.071
			Dairy w/out hauling		550	12809194	23205	92.801	0.928
Central Texas Dairy 550	550	HAC	Costal hay	No till --> no till	400	2725314	6813	2433.316	1.217

Table A-5 Continued

Farm name	Farm size (head)	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
			Green cut winter wheat	Full till -->full till	500	425381	6046	2015.261	1.008
			Sorghum silage	Full till -->full till	200	343176	6041	503.397	0.252
			Dairy w/hauling		550	20279672	36214	187.044	1.870
			Dairy w/out hauling		550	18930510	33804	174.600	1.746
Central Texas Dairy 1300	1300	HAC	Winter wheat silage	Full till -->full till	560	1446600	7126	890.763	0.445
			Dairy w/hauling		550	54590723	41672	503.502	5.035
			Dairy w/out hauling		550	50975045	38912	470.154	4.702
East Texas Dairy 400	400	HAC	Ryegrass	No till --> no till	400	573305	5549	554.862	0.277
			Coastal hay	No till --> no till	125	12340	607	75.849	0.038
			Dairy w/hauling		400	9005759	21859	128.654	1.287
			Dairy w/out hauling		400	7884707	19138	112.639	1.126
East Texas Dairy 1000	1000	HAC	Corn silage	Full till -->full till	200	1204809	6024	376.503	0.188
			Sorghum grain silage	Full till -->full till	275	412258	7441	744.148	0.372
			Grass hay	No till --> no till	550	176714	685	171.226	0.086
			Dairy w/hauling		1000	29293882	29177	133.958	1.340

Table A-5 Continued

Farm name	Farm size (head)	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
			Dairy w/out hauling		1000	27682886	27573	126.591	1.266
Missouri Grazing Dairy 550	550	HAC	Grass/legume	No till --> no till	305	1292363	4237	1059.314	0.530
			Corn silage	Full till -->full till	40	83313	4310	253.547	0.127
			Double crop millet	Full till -->full till	40	8457	2788	929.357	0.465
			Dairy w/hauling		500	8519506	16705	132.311	1.323
			Dairy w/out hauling		500	7871692	15435	122.250	1.223
Nevada Dairy 500	500	HAC	Dry cow hay	No till --> no till	150	197883	2263	431.117	0.216
			Dairy w/hauling		500	13093296	26082	111.432	1.114
			Dairy w/out hauling		500	10182222	20283	86.657	0.867
North Florida Dairy 550	550	LAC	Grass hay	No till --> no till	130	20837	4214	690.888	0.345
			Pasture	No till --> no till	220	98799	765	765.228	0.383
			Irrigated corn silage	Full till -->full till	250	165770	4131	187.774	0.094
			Irrigated ryegrass	No till --> no till	250	264319	3881	646.780	0.323
			Dairy w/hauling		550	18147744	31561	172.446	1.724

Table A-5 Continued

Farm name	Farm size (head)	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
			Dairy w/out hauling		550	17001608	29568	161.555	1.616
North Texas Dairy 3000	3000	HAC	Sorghum silage	Full till -->full till	300	967724	4294	214.684	0.107
			Winter wheat	Full till -->full till	300	1041961	5229	580.997	0.290
			Dairy w/hauling		3000	127769211	42238	194.794	1.948
			Dairy w/out hauling		3000	117999954	39008	179.900	1.799
South Florida Dairy 1500	1500	Spodic soil	Grass silage	No till --> no till	400	1615009	9328	333.137	0.167
			Dairy w/hauling		1500	30470115	20112	104.171	1.042
			Dairy w/out hauling		1500	26925148	17772	92.052	0.921
Vermont Dairy 140	140	Spodic soil	Mixed hay	No till --> no till	60	5255	561	186.861	0.093
			Corn silage	Full till -->full till	80	39346	5065	281.367	0.141
			Haylage	No till --> no till	80	15476	1076	97.846	0.049
			Dairy w/hauling		140	2493671	17561	83.565	0.836
			Dairy w/out hauling		140	2325584	16377	77.933	0.779
Vermont Dairy 400	400	Spodic soil	Hay	No till --> no till	100	10938	517	206.654	0.103

Table A-5 Continued

Farm name	Farm size (head)	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
			Corn silage	Full till -->full till	400	1024978	5613	311.861	0.156
			Haylage	No till --> no till	450	110990	979	139.791	0.070
			Dairy w/hauling		400	7279335	18198	75.653	0.757
			Dairy w/out hauling		400	6828591	17071	70.969	0.710
Washington Dairy 250	250	Volcanic soils	Grass silage	No till --> no till	140	46395	2834	157.459	0.079
			Corn silage	Full till -->full till	60	70154	3960	180.003	0.090
			Dairy w/hauling		250	4837201	19349	78.091	0.781
			Dairy w/out hauling		250	4132347	16529	66.712	0.667
Washington Dairy 850	850	Volcanic soils	Grass silage	No till --> no till	450	67620	2999	187.449	0.094
			Dairy w/hauling		850	15791150	18448	72.130	0.721
			Dairy w/out hauling		850	14877241	17380	67.956	0.680
Western New York Dairy 600	600	HAC	Corn silage	Full till -->full till	600	850583	4248	235.986	0.118
			Alfalfa haylage	No till --> no till	450	234809	1315	119.586	0.060
			Dairy w/hauling		600	13704015	22614	99.283	0.993
			Dairy w/out hauling		600	12824946	21163	92.914	0.929

Table A-5 Continued

Farm name	Farm size (head)	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
Western New York Dairy 1200	1200	HAC	Corn silage	Full till -->full till	900	438736	5007	278.144	0.139
			Dairy w/hauling		1200	31092038	25696	110.120	1.101
			Dairy w/out hauling		1200	29369777	24273	104.020	1.040
Wisconsin Dairy 145	145	HAC	Alfalfa Hay	No till --> no till	90	576	724	289.477	0.145
			Winter wheat	Full till -->full till	50	82891	1658	23.683	0.012
			Corn silage	Full till -->full till	60	21343	5151	257.545	0.129
			Corn	Full till -->full till	150	266590	5337	1270.685	0.635
			Alfalfa Haylage	No till --> no till	120	19531	887	98.594	0.049
			Soybean	Full till -->full till	130	69400	1114	795.684	0.398
			Dairy w/hauling		145	3776193	26043	103.177	1.032
			Dairy w/out hauling		145	3646811	25150	99.642	0.996
Wisconsin Dairy 1000	1000	HAC	Winter wheat	Reduced till --> no till	100	176270	1763	23.503	0.392
			Corn silage	Reduced till --> no till	600	454641	3968	220.452	0.110
			Alfalfa haylage	No till --> no till	600	381810	3696	462.055	0.231

Table A-5 Continued

Farm name	Farm size (head)	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
			Corn	Reduced till --> no till	600	436855	4123	981.740	0.491
			Soybean	Reduced till --> no till	100	150182	1502	37.546	0.626
			Dairy w/hauling		1000	23772107	23677	90.955	0.910
			Dairy w/out hauling		1000	22920898	22830	87.699	0.877

Table A-6 GHG Emission Summary for Cow-Calf Operations, by Farm and Crop

Farm name	Farm size (head)	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb $CO_{2/}$yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
California Cow-calf 500	500	HAC	Cow-calf	No till --> no till	500	2406929	4541	781.326	7.813
Central Missouri Cow-calf 400	400	HAC	Pasture	No till --> no till	1150	50523	529	481.169	0.241
			Mixed hay	No till --> no till	370	171546	1320	659.792	0.330
			Alfalfa	No till --> no till	40	10656	740	148.006	0.074
			Cow-calf		400	2573219	6186	606.148	6.061
Colorado Cow-calf 250	250	HAC	Meadow hay	No till --> no till	450	89709	1424	711.979	0.356
			Cow-calf		250	2054593	7842	1425.613	14.256
Dade Missouri Cow-calf 250	250	HAC	Soybean	Full till --> full till	40	6765	1579	47.834	0.797
			Double cropped soybean	Full till --> full till	120	30609	726	30.249	0.504
			Winter wheat	Full till --> full till	120	107982	2500	45.447	0.757
			Fescue hay	No till --> no till	280	46185	1539	769.742	0.385
			Fescue pasture	No till --> no till	570	871755	1529	1019.596	0.510
			Corn	Full till --> full till	120	601189	5755	46.040	0.822

Table A-6 Continued

Farm name	Farm size (head)	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb CO_2/yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
			Double cropped fescue seed	No till --> no till	280	3802218	13579	54.317	0.027
			Cow-calf		250	3366460	13150	793.004	7.930
Florida Cow-calf 1155	1155	Spodic	Improved pasture	No till --> no till	3560	6798	955	1037.833	0.519
			Cow-calf	No till --> no till	1155	3237014	2695	762.512	7.625
Montana Cow-calf 500	500	HAC	Alfalfa	Reduced till --> reduced till	640	1611	15	25.178	0.420
			Alfalfa establishment	Reduced till --> reduced till	80	1077	38		
			Cow-calf		500	1620324	3086	381.684	3.817
Nevada Cow-calf 700	700	HAC	Meadow hay	No till --> no till	975	192684	1101	629.173	0.315
			Cow-calf		700	2262200	3057	532.884	5.329
New Mexico Cow-calf 240	240	HAC	Cow-calf		700	1699518	2297	1221.181	12.212

Table A-6 Continued

Farm name	Farm size (head)	Soil Type	Crop	Tillage practice	Acres or head in enterprise	Total lb CO_2 eq	Per-acre CO_2 emission (lb CO_2 eq/acre)	Per-yield unit CO_2 emission (lb $CO_{2/}$yield unit)	GHG intensity (lb CO_2 eq/harvested lb)
South Dakota Cow-calf 375	375	HAC	Perennial hay	No till --> no till	800	8134	34	34.248	0.017
			Annual hay	No till --> no till	350	233717	1039	692.495	0.346
			Cow-calf		375	2717297	6967	1088.704	10.887
Southern Texas Cow-calf 200	200	HAC	Improved pasture	No till --> no till	400	466708	1815	1209.984	0.605
			Hay	No till --> no till	100	73601	2931	1221.194	0.611
			Cow-calf		200	1465399	7045	1407.955	14.080
Texas Rolling Plains Cow-calf 500	500	HAC	Cow-calf		500	3028732	5715	1055.381	10.554
Wyoming Cow-calf 435	435	HAC	Alfalfa	No till --> no till	90	16767	1105	220.906	0.110
			Meadow hay	No till --> no till	200	8529	548	182.718	0.091
			Alfalfa/Oats Mix	No till --> no till	15	15162	3581	1790.691	0.895
			Cow-calf		435	2194930	4824	1577.158	15.772

APPENDIX B

FARM-SPECIFIC EMISSION FACTORS

Table B-1 Specific-to-Farm Factors, Indiana Feedgrain 1000

Parameter	Description	Unit	Corn	Soybean
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.675	1.675
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0832	0.0832
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	406	406
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	848	848
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.00	0.00
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.03	0.03
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.93	0.93
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.01	0.01
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	65	65
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	65	65
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-management tillage practices at the end of the period	index	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	0.94

[a]Factors are from USDA (2010) [b]Factors are from DOE (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-2 Specific-to-Farm Factors, Indiana Feedgrain 2200

Parameter	Description	Unit	Corn	Soybean
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.675	1.675
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0832	0.0832
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	406	406
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	848	848
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.00	0.00
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.03	0.03
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.93	0.93
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.01	0.01
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	65	65
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	65	65
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-management tillage practices at the end of the period	index	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	0.94

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-3 Specific-to-Farm Factors, Iowa Feedgrain 1350

Parameter	Description	Unit	Corn	Soybean
$Price_{diesel,2009}$ [a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.675	1.675
$Price_{electricity,2009}$ [b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0755	0.0755
$fertPrice_{Ammonium\ Nitrate,2009}$ [a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	406	406
$fertPrice_{Phosphoric\ Acid,2009}$ [a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555
$fertPrice_{Potash,2009}$ [a]	price of K_2O in 2009	U.S. dollars ton^{-1}	848	848
$herbPrice_{atrazine,2009}$ [a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$ [a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5
$Prop_{NF}$ [b]	proportion of electricity from nuclear fission	index	0.09	0.09
$Prop_{NG}$ [b]	proportion of electricity from natural gas	index	0.02	0.02
$Prop_{CL}$ [b]	proportion of electricity from coal	index	0.72	0.72
$Prop_{WB}$ [b]	proportion of electricity from woody biomass	index	0.00	0.00
$Prop_{HB}$ [b]	proportion of electricity from herbaceous biomass	index	0.00	0.00
$Prop_{WND}$ [b]	proportion of electricity from with wind	index	0.14	0.14
$Prop_{HE}$ [b]	proportion of electricity from hydroelectric dams	index	0.02	0.02
$SOC_{Ref,Z,0}$ [c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	65	65
$SOC_{Ref,Z,0-t}$ [c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	65	65
$F_{Lu,Z,0}$ [c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69
$F_{Lu,Z,0-t}$ [c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69
$F_{Mg,Z,0}$ [c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.15	1.15
$F_{Mg,Z,0-t}$ [c]	SOC scaling factor- tillage practices at the end of the period	index	1.08	1.08
$F_{O,Z,0}$ [c]	SOC scaling factor-residues at beginning of the period	index	1	1
$F_{O,Z,0-t}$ [c]	SOC scaling factor-residues at end of the period	index	1	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-4 Specific-to-Farm Factors, Iowa Feedgrain 3400

Parameter	Description	Unit	Corn	Soybean
$Price_{diesel,2009}$ [a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.675	1.675
$Price_{electricity,2009}$ [b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0755	0.0755
$fertPrice_{Ammonium\ Nitrate,2009}$ [a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	406	406
$fertPrice_{Phosphoric\ Acid,2009}$ [a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555
$fertPrice_{Potash,2009}$ [a]	price of K_2O in 2009	U.S. dollars ton^{-1}	848	848
$herbPrice_{atrazine,2009}$ [a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$ [a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5
$Prop_{NF}$ [b]	proportion of electricity from nuclear fission	index	0.09	0.09
$Prop_{NG}$ [b]	proportion of electricity from natural gas	index	0.02	0.02
$Prop_{CL}$ [b]	proportion of electricity from coal	index	0.72	0.72
$Prop_{WB}$ [b]	proportion of electricity from woody biomass	index	0.00	0.00
$Prop_{HB}$ [b]	proportion of electricity from herbaceous biomass	index	0.00	0.00
$Prop_{WND}$ [b]	proportion of electricity from with wind	index	0.14	0.14
$Prop_{HE}$ [b]	proportion of electricity from hydroelectric dams	index	0.02	0.02
$SOC_{Ref,Z,0}$ [c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	65	65
$SOC_{Ref,Z,0-t}$ [c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	65	65
$F_{Lu,Z,0}$ [c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69
$F_{Lu,Z,0-t}$ [c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69
$F_{Mq,Z,0}$ [c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.15	1.15
$F_{Mg,Z,0-t}$ [c]	SOC scaling factor-tillage practices at the end of the period	index	1.08	1.08
$F_{O,Z,0}$ [c]	SOC scaling factor-residues at beginning of the period	index	1	1
$F_{O,Z,0-t}$ [c]	SOC scaling factor-residues at end of the period	index	1	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-5 Specific-to-Farm Factors, Missouri Feedgrain 1850

Parameter	Description	Unit	Corn	Soybean	Non-N-fixing forages	Alfalfa
$Price_{diesel,2009}$ [a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.675	1.675	1.675	1.675
$Price_{electricity,2009}$ [b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0696	0.0696	0.0696	0.0696
$fertPrice_{Ammonium\ Nitrate,2009}$ [a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	406	406	406	406
$fertPrice_{Phosphoric\ Acid,2009}$ [a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555	555	555
$fertPrice_{Potash,2009}$ [a]	price of K_2O in 2009	U.S. dollars ton^{-1}	848	848	848	848
$herbPrice_{atrazine,2009}$ [a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$ [a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$ [b]	proportion of electricity from nuclear fission	index	0.12	0.12	0.12	0.12
$Prop_{NG}$ [b]	proportion of electricity from natural gas	index	0.04	0.04	0.04	0.04
$Prop_{CL}$ [b]	proportion of electricity from coal	index	0.81	0.81	0.81	0.81
$Prop_{WB}$ [b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00
$Prop_{HB}$ [b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00
$Prop_{WND}$ [b]	proportion of electricity from with wind	index	0.01	0.01	0.01	0.01
$Prop_{HE}$ [b]	proportion of electricity from hydroelectric dams	index	0.02	0.02	0.02	0.02
$SOC_{Ref,Z,0}$ [c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	65	65	65	65
$SOC_{Ref,Z,0\text{-}t}$ [c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	65	65	65	65
$F_{Lu,Z,0}$ [c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69
$F_{Lu,Z,0\text{-}t}$ [c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$ [c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1.08	1.08
$F_{Mg,Z,0\text{-}t}$ [c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1.08	1.08
$F_{O,Z,0}$ [c]	SOC scaling factor-residues at beginning of the period	index	1	0.94	0.94	1.07
$F_{O,Z,0\text{-}t}$ [c]	SOC scaling factor-residues at end of the period	index	1	0.94	0.94	1.07

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-6 Specific-to-Farm Factors, Missouri Feedgrain 2050

Parameter	Description	Unit	Corn	Soybean
$Price_{diesel,2009}$ [a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.675	1.675
$Price_{electricity,2009}$ [b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0696	0.0696
$fertPrice_{Ammonium\ Nitrate,2009}$ [a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	406	406
$fertPrice_{Phosphoric\ Acid,2009}$ [a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555
$fertPrice_{Potash,2009}$ [a]	price of K_2O in 2009	U.S. dollars ton^{-1}	848	848
$herbPrice_{atrazine,2009}$ [a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$ [a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5
$Prop_{NF}$ [b]	proportion of electricity from nuclear fission	index	0.12	0.12
$Prop_{NG}$ [b]	proportion of electricity from natural gas	index	0.04	0.04
$Prop_{CL}$ [b]	proportion of electricity from coal	index	0.81	0.81
$Prop_{WB}$ [b]	proportion of electricity from woody biomass	index	0.00	0.00
$Prop_{HB}$ [b]	proportion of electricity from herbaceous biomass	index	0.00	0.00
$Prop_{WND}$ [b]	proportion of electricity from with wind	index	0.01	0.01
$Prop_{HE}$ [b]	proportion of electricity from hydroelectric dams	index	0.02	0.02
$SOC_{Ref,Z,0}$ [c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	65	65
$SOC_{Ref,Z,0-t}$ [c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	65	65
$F_{Lu,Z,0}$ [c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69
$F_{Lu,Z,0-t}$ [c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69
$F_{Mg,Z,0}$ [c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1
$F_{Mg,Z,0-t}$ [c]	SOC scaling factor-tillage practices at the end of the period	index	1	1
$F_{O,Z,0}$ [c]	SOC scaling factor-residues at beginning of the period	index	1	0.94
$F_{O,Z,0-t}$ [c]	SOC scaling factor-residues at end of the period	index	1	0.94

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011) (2011). [d]Factors are from Eggleston et al. (2006).

Table B-7 Specific to Farm Factors, Missouri Feedgrain 4000

Parameter	Description	Unit	Corn	Soybean
$Price_{diesel,2009}$ [a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.675	1.675
$Price_{electricity,2009}$ [b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0696	0.0696
$fertPrice_{Ammonium\ Nitrate,2009}$ [a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	406	406
$fertPrice_{Phosphoric\ Acid,2009}$ [a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555
$fertPrice_{Potash,2009}$ [a]	price of K_2O in 2009	U.S. dollars ton^{-1}	848	848
$herbPrice_{atrazine,2009}$ [a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$ [a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5
$Prop_{NF}$ [b]	proportion of electricity from nuclear fission	index	0.12	0.12
$Prop_{NG}$ [b]	proportion of electricity from natural gas	index	0.04	0.04
$Prop_{CL}$ [b]	proportion of electricity from coal	index	0.81	0.81
$Prop_{WB}$ [b]	proportion of electricity from woody biomass	index	0.00	0.00
$Prop_{HB}$ [b]	proportion of electricity from herbaceous biomass	index	0.00	0.00
$Prop_{WND}$ [b]	proportion of electricity from with wind	index	0.01	0.01
$Prop_{HE}$ [b]	proportion of electricity from hydroelectric dams	index	0.02	0.02
$SOC_{Ref,Z,0}$ [c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51
$SOC_{Ref,Z,0-t}$ [c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51
$F_{Lu,Z,0}$ [c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69
$F_{Lu,Z,0-t}$ [c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69
$F_{Mg,Z,0}$ [c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1
$F_{Mg,Z,0-t}$ [c]	SOC scaling factor-tillage practices at the end of the period	index	1	1
$F_{O,Z,0}$ [c]	SOC scaling factor-residues at beginning of the period	index	1	0.94
$F_{O,Z,0-t}$ [c]	SOC scaling factor-residues at end of the period	index	1	0.94

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-8 Specific-to-Farm Factors, Nebraska Feedgrain 2400

Parameter	Description	Unit	Corn	Yellow Food Grade Corn	Soybean
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.66	1.66	1.66
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0733	0.0733	0.0733
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	406	406	406
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555	555
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	848	848	848
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.28	0.28	0.28
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.01	0.01	0.01
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.69	0.69	0.69
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.01	0.01	0.01
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.01	0.01	0.01
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42	42
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.08	1.08	1.08
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	1	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	1	0.94

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-9 Specific-to-Farm Factors, Nebraska Feedgrain 4300

Parameter	Description	Unit	Irrigated corn	Irrigated food grade corn	Irrigated soybeans	Alfalfa	Alfalfa establishment
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.66	1.66	1.66	1.66	1.66
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0733	0.0733	0.0733	0.0733	0.07
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	406	406	406	406	406
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555	555	555	555
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	848	848	848	848	848
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.28	0.28	0.28	0.28	0.28
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.01	0.01	0.01	0.01	0.01
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.69	0.69	0.69	0.69	0.69
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.01	0.01	0.01	0.01	0.01
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.01	0.01	0.01	0.01	0.01
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42	42	42	42
$SOC_{Ref,Z,0\text{-}t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42	42	42	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8	0.8	0.8
$F_{Lu,Z,0\text{-}t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8	0.8	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.08	1.08	1.08	1.02	1.1
$F_{Mg,Z,0\text{-}t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1	1.02	1.1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	1	0.94	1.07	0.94
$F_{O,Z,0\text{-}t}$[c]	SOC scaling factor-residues at end of the period	index	1	1	0.94	1.07	0.94

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-10 Specific-to-Farm Factors, North Dakota Feedgrain 2500

Parameter	Description	Unit	Winter wheat	Barley	Sunflower	Corn	Soybean
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.66	1.66	1.66	1.66	1.66
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0681	0.0681	0.0681	0.0681	0.0681
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	400	400	400	400	400
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555	555	555	555
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	828	828	828	828	828
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.00	0.00	0.00	0.00	0.00
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.00	0.00	0.00	0.00	0.00
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.87	0.87	0.87	0.87	0.87
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.09	0.09	0.09	0.09	0.09
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.04	0.04	0.04	0.04	0.04
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42	42	42	42
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42	42	42	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8	0.8	0.8
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8	0.8	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.15	1.15	1.08	1	1.1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1.08	1.08	1.08	1	1.1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	1	0.94	1	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	1	0.94	1	0.94

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-11 Specific-to-Farm Factors, North Dakota Feedgrain 8000

Parameter	Description	Unit	Winter wheat	Barley	Sunflower	Soybean	CRP	Corn
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.66	1.66	1.66	1.66	1.66	1.66
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0681	0.0681	0.0681	0.0681	0.0681	0.0681
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	400	400	400	400	400	400
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555	555	555	555	555
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	828	828	828	828	828	828
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.87	0.87	0.87	0.87	0.87	0.87
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.09	0.09	0.09	0.09	0.09	0.09
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.04	0.04	0.04	0.04	0.04	0.04
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42	42	42	42	42
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42	42	42	42	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8	0.8	0.82	0.8
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8	0.8	0.8	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.15	1.15	1.15	1	1.15	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-management tillage practices at the end of the period	index	1.08	1.08	1.08	1	1.15	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	1	0.94	1	1.07	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	1	0.94	1	1.07	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-12 Specific-to-Farm Factors, South Carolina Feedgrain 1800

Parameter	Description	Unit	Corn	Winter wheat	Soybean	Cotton	Irrigated Cotton	Virginia Peanut	Runner Peanut
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.664	1.664	1.664	1.664	1.664	1.664	1.664
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0874	0.0874	0.0874	0.0874	0.0874	0.0874	0.0874
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	542	542	542	542	542	542	542
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	904	904	904	904	904	904	904
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	943	943	943	943	943	943	943
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.52	0.52	0.52	0.52	0.52	0.52	0.52
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.10	0.10	0.10	0.10	0.10	0.10	0.10
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.34	0.34	0.34	0.34	0.34	0.34	0.34
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.02	0.02	0.02	0.02	0.02	0.02	0.02
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.02	0.02	0.02	0.02	0.02	0.02	0.02
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	40	40	40	40	40	40	40
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	40	40	40	40	40	40	40
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69	0.82	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.08	1.15	1.08	1.08	1.08	1.08	1.08
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-management tillage practices at the end of the period	index	1	1.08	1	1	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	1	0.94	0.94	0.94	1	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	1	0.94	0.94	0.94	1	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-13 Specific-to-Farm Factors, South Carolina Feedgrain 3500

Parameter	Description	Unit	Corn	Soybean	Double crop soybeans	Winter wheat
$Price_{diesel,2009}$ [a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.664	1.664	1.664	1.664
$Price_{electricity,2009}$ [b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0874	0.0874	0.0874	0.0874
$fertPrice_{Ammonium\ Nitrate,2009}$ [a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	542	542	542	542
$fertPrice_{Phosphoric\ Acid,2009}$ [a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	904	904	904	904
$fertPrice_{Potash,2009}$ [a]	price of K_2O in 2009	U.S. dollars ton^{-1}	943	943	943	943
$herbPrice_{atrazine,2009}$ [a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$ [a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$ [b]	proportion of electricity from nuclear fission	index	0.52	0.52	0.52	0.52
$Prop_{NG}$ [b]	proportion of electricity from natural gas	index	0.10	0.10	0.10	0.10
$Prop_{CL}$ [b]	proportion of electricity from coal	index	0.34	0.34	0.34	0.34
$Prop_{WB}$ [b]	proportion of electricity from woody biomass	index	0.02	0.02	0.02	0.02
$Prop_{HB}$ [b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00
$Prop_{WND}$ [b]	proportion of electricity from with wind	index	0.00	0.00	0.00	0.00
$Prop_{HE}$ [b]	proportion of electricity from hydroelectric dams	index	0.02	0.02	0.02	0.02
$SOC_{Ref,Z,0}$ [c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	40	40	40	40
$SOC_{Ref,Z,0-t}$ [c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	40	40	40	40
$F_{Lu,Z,0}$ [c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$ [c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$ [c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.08	1.08	1.08	1.15
$F_{Mg,Z,0-t}$ [c]	SOC scaling factor-management tillage practices at the end of the period	index	1	1	1	1.08
$F_{O,Z,0}$ [c]	SOC scaling factor-residues at beginning of the period	index	1	0.94	0.94	1
$F_{O,Z,0-t}$ [c]	SOC scaling factor-residues at end of the period	index	1	0.94	0.94	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-14 Specific-to-Farm Factors, Tennessee Feedgrain 900

Parameter	Description	Unit	Corn	Winter wheat	Soybean	White corn
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.745	1.745	1.745	1.745
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0961	0.0961	0.0961	0.0961
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	440	440	440	440
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	664	664	664	664
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	838	838	838	838
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.34	0.34	0.34	0.34
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.01	0.01	0.01	0.01
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.52	0.52	0.52	0.52
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.01	0.01	0.01	0.01
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.00	0.00	0.00	0.00
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.13	0.13	0.13	0.13
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51	51	51
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51	51	51
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.15	1.15	1.15	1.15
$F_{Mg,Z,0-t}$[c]	SOC scaling factor- tillage practices at the end of the period	index	1.08	1.08	1.08	1.08
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	1	0.94	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	1	0.94	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-15 Specific-to-Farm Factors, Tennessee Feedgrain 2200

Parameter	Description	Unit	Corn	Winter wheat	Soybean	Double crop soybean
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.745	1.745	1.745	1.745
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0961	0.0961	0.0961	0.0961
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	440	440	440	440
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	664	664	664	664
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	838	838	838	838
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.34	0.34	0.34	0.34
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.01	0.01	0.01	0.01
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.52	0.52	0.52	0.52
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.01	0.01	0.01	0.01
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.00	0.00	0.00	0.00
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.13	0.13	0.13	0.13
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51	51	51
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51	51	51
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	1	0.94	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	1	0.94	0.94

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-16 Specific-to-Farm Factors, Texas Blacklands Feedgrain 1600

Parameter	Description	Unit	Sorghum	Cotton	Winter wheat	Corn	Cow-calf
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725	1.725	1.725	1.725	1.725
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.097	0.0966	0.0966	0.0966	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441	441	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841	841	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.105	0.105	0.105	0.105	0.105
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.476	0.476	0.476	0.476	0.476
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.351	0.351	0.351	0.351	0.351
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.000	0.000	0.000	0.000	0.000
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.001	0.001	0.001	0.001	0.001
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.050	0.050	0.050	0.050	0.050
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.003	0.003	0.003	0.003	0.003
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51	51	51	0
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51	51	51	0
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69	0
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69	0
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1	1	0
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-management tillage practices at the end of the period	index	1	1	1	1	1.08
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	0.94	1	1	0
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	0.94	1	1	0
$EF_{orgsoils,Z}$[d]	N emission factor for organic soils	kg N_2O-N ha^{-1} year^{-1}	8	8	8	8	8
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 head^{-1} year^{-1}	2	2	2	2	1
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 head^{-1} year^{-1}	98	98	98	98	98

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-17 Specific-to-Farm Factors, Texas Hill County Grain 2000

Parameter	Description	Unit	Sorghum	Cotton	Winter wheat	Corn	Cow-calf
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.73	1.725	1.725	1.725	1.725
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.1	0.0966	0.0966	0.097	0.097
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441	441	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841	841	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.10	0.10	0.10	0.10	0.10
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.48	0.48	0.48	0.48	0.48
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.35	0.35	0.35	0.35	0.35
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.05	0.05	0.05	0.05	0.05
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51	51	51	51
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51	51	51	51
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1.15	1.08	1.08
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-management tillage practices at the end of the period	index	1	1	1.08	1	1.08
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	0.94	1	1	1.38
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	0.94	1	1	1.38
$EF_{orgsoils,Z}$[d]	N emission factor for organic soils	kg N_2O-N ha^{-1} $year^{-1}$	8	8	8	8	8
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2	2	2	1
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98	98	98	55

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-18 Specific-to-Farm Factors, Texas Northern Plains Feedgrain 3000

Parameter	Description	Unit	Irrigated winter wheat	Irrigated sorghum	Irrigated corn	Irrigated Cotton	Cotton	Winter wheat
$Price_{diesel,2009}^{a}$	price of diesel in 2009	U.S. dollars gal^{-1}	1.725	1.73	1.725	1.725	1.725	1.725
$Price_{electricity,2009}^{b}$	price of electricity in 2009	U.S. dollars kwh^{-1}	0.097	0.1	0.097	0.0966	0.0966	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}^{a}$	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}^{a}$	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441	441	441	441
$fertPrice_{Potash,2009}^{a}$	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841	841	841	841
$herbPrice_{atrazine,2009}^{a}$	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}^{a}$	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}^{b}$	proportion of electricity from nuclear fission	index	0.10	0.10	0.10	0.10	0.10	0.10
$Prop_{NG}^{b}$	proportion of electricity from natural gas	index	0.48	0.48	0.48	0.48	0.48	0.48
$Prop_{CL}^{b}$	proportion of electricity from coal	index	0.35	0.35	0.35	0.35	0.35	0.35
$Prop_{WB}^{b}$	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{HB}^{b}$	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}^{b}$	proportion of electricity from with wind	index	0.05	0.05	0.05	0.05	0.05	0.05
$Prop_{HE}^{b}$	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00	0.00	0.00	0.00
$SOC_{Ref,Z,0}^{c}$	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	37	37	37	37	37	37
$SOC_{Ref,Z,0-t}^{c}$	reference value of soil organic C at end of study period	tonnes C ha^{-1}	37	37	37	37	37	37
$F_{Lu,Z,0}^{c}$	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8	0.8	0.8	0.8
$F_{Lu,Z,0-t}^{c}$	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8	0.8	0.8	0.8
$F_{Mg,Z,0}^{c}$	SOC scaling factor-tillage practices at the beginning of the period	index	1.1	1.02	1.02	1.02	1.02	1.1
$F_{Mg,Z,0-t}^{c}$	SOC scaling factor-management tillage practices at the end of the period	index	1.02	1	1	1	1	1.02
$F_{O,Z,0}^{c}$	SOC scaling factor-residues at beginning of the period	index	1	0.94	1	0.94	0.94	1
$F_{O,Z,0-t}^{c}$	SOC scaling factor-residues at end of the period	index	1	0.94	1	0.94	0.94	1
$EF_{orgsoils,Z}^{d}$	N emission factor for organic soils	kg N_2O-N ha^{-1} $year^{-1}$	8	8	8	8	8	8
$EF_{manure,ND,\tau}^{d}$	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2	2	2	2	2
$EF_{manure,D,\tau}^{d}$	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98	98	98	98	98

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-19 Specific-to-Farm Factors, Texas Northern Plains Feedgrain 8000

Parameter	Description	Unit	Irrigated winter wheat	Irrigated sorghum	Irrigated corn	Winter wheat	Sorghum	Irrigated cotton
$Price_{diesel,2009}$ [a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725	1.725	1.725	1.725	1.725	1.725
$Price_{electricity,2009}$ [b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0966	0.0966	0.0966	0.0966	0.0966	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}$ [a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$ [a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441	441	441	441
$fertPrice_{Potash,2009}$ [a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841	841	841	841
$herbPrice_{atrazine,2009}$ [a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$ [a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$ [b]	proportion of electricity from nuclear fission	index	0.10	0.10	0.10	0.10	0.10	0.10
$Prop_{NG}$ [b]	proportion of electricity from natural gas	index	0.48	0.48	0.48	0.48	0.48	0.48
$Prop_{CL}$ [b]	proportion of electricity from coal	index	0.35	0.35	0.35	0.35	0.35	0.35
$Prop_{WB}$ [b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{HB}$ [b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$ [b]	proportion of electricity from with wind	index	0.05	0.05	0.05	0.05	0.05	0.05
$Prop_{HE}$ [b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00	0.00	0.00	0.00
$SOC_{Ref,Z,0}$ [c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	37	37	37	37	37	37
$SOC_{Ref,Z,0-t}$ [c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	37	37	37	37	37	37
$F_{Lu,Z,0}$ [c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8	0.8	0.8	0.8
$F_{Lu,Z,0-t}$ [c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8	0.8	0.8	0.8
$F_{Mg,Z,0}$ [c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.1	1.02	1.02	1.1	1.02	1.02
$F_{Mg,Z,0-t}$ [c]	SOC scaling factor-management tillage practices at the end of the period	index	1.02	1	1	1.02	1	1
$F_{O,Z,0}$ [c]	SOC scaling factor-residues at beginning of the period	index	1	1	1	0.94	1	0.94
$F_{O,Z,0-t}$ [c]	SOC scaling factor-residues at end of the period	index	1	1	1	0.94	1	0.94

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-20 Specific-to-Farm Factors, Texas Panhandle Feedgrain 3760

Parameter	Description	Unit	Irrigated corn	Irrigated white corn	Irrigated cotton	Irrigated winter wheat	Winter wheat	CRP	Cotton	Corn silage
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725	1.725	1.725	1.725	1.725	1.725	1.725	1.725
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0966	0.097	0.0966	0.0966	0.0966	0.0966	0.0966	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361	361	361	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441	441	441	441	441	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841	841	841	841	841	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	37	37	37	37	37	37	37	37
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	37	37	37	37	37	37	37	37
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8	0.8	0.8	0.93	0.8	0.8
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1	1	1.08	1.1	0	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-management tillage practices at the end of the period	index	1	1	1	1	1	1	0	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	1	0.94	1	1	1.07	0	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	1	0.94	1	1	1.07	0	0.94

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-21 Specific-to-Farm Factors, Uvalde Texas Feedgrain 1200

Parameter	Description	Unit	Irrigated corn	Irrigated cotton	Irrigated sorghum	Winter wheat
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725	1.725	1.725	1.725
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0966	0.0966	0.097	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.10	0.10	0.10	0.10
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.48	0.48	0.48	0.48
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.35	0.35	0.35	0.35
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.05	0.05	0.05	0.05
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	37	37	37	37
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	37	37	37	37
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8	0.8
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.02	1.02	1.02	1.02
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	0.94	1	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	0.94	1	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-22 Specific-to-Farm Factors, Adams County Washington Wheat 3500

Parameter	Description	Unit	Winter wheat	CRP
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.714	1.714
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0696	0.0696
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	539	539
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	887	887
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	955	955
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.06	0.06
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.11	0.11
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.07	0.07
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.01	0.01
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.03	0.03
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.70	0.70
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42
$SOC_{Ref,Z,0\text{-}t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.93
$F_{Lu,Z,0\text{-}t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1.1
$F_{Mg,Z,0\text{-}t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	1.07
$F_{O,Z,0\text{-}t}$[c]	SOC scaling factor-residues at end of the period	index	1	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-22 Specific-to-Farm Factors, Central Kansas Wheat 2000

Parameter	Description	Unit	Winter wheat	Corn	Sorghum	Soybean
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.66	1.66	1.66	1.66
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0787	0.0787	0.0787	0.0787
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	400	400	400	400
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555	555	555
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	828	828	828	828
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.19	0.19	0.19	0.19
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.06	0.06	0.06	0.06
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.69	0.69	0.69	0.69
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.06	0.06	0.06	0.06
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	37	37	37	37
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	37	37	37	37
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8	0.93
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	1	1	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	1	1	0.94

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-24 Specific-to-Farm Factors, Central Kansas Wheat 4500

Parameter	Description	Unit	Winter wheat	Corn	Sorghum	Soybean
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.66	1.66	1.66	1.66
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0787	0.0787	0.0787	0.0787
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	400	400	400	400
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555	555	555
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	828	828	828	828
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.19	0.19	0.19	0.19
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.06	0.06	0.06	0.06
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.69	0.69	0.69	0.69
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.06	0.06	0.06	0.06
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	37	37	37	37
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	37	37	37	37
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8	0.93
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-management tillage practices at the end of the period	index	1	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	1	1	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	1	1	0.94

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-25 Specific-to-Farm Factors, Montana Wheat 4500 Feedgrain

Parameter	Description	Unit	Winter wheat	Spring wheat
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.628	1.628
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0832	0.0832
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	458	458
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	1100	1100
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	893	893
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.00	0.00
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.00	0.00
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.58	0.58
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.03	0.03
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.36	0.36
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-26 Specific-to-Farm Factors, Northwest Kansas Wheat 4000

Parameter	Description	Unit	Winter wheat	CWheat	Sorghum	Corn	Cow-calf
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.66	1.66	1.66	1.66	1.66
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0787	0.0787	0.0787	0.0787	0.0787
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	400	400	400	400	400
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555	555	555	555
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	828	828	828	828	828
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.19	0.19	0.19	0.19	0.19
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.06	0.06	0.06	0.06	0.06
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.69	0.69	0.69	0.69	0.69
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.06	0.06	0.06	0.06	0.06
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42	42	42	42.00
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42	42	42	42.00
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8	0.93	0.93
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8	0.8	0.80
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.1	1.1	1.1	1.1	1.10
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1.02	1.02	1.02	1.02	1.02
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	1	1	1	1.00
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	1	1	1	1.00
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2	2	2	1
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98	98	98	48

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-27 Specific-to-Farm Factors, Northwest Kansas Wheat 5500

Parameter	Description	Unit	Winter wheat	Winter wheat	Sorghum	Corn	Cow-calf
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.66	1.66	1.66	1.66	1.66
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.079	0.079	0.0787	0.0787	0.0787
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	400	400	400	400	400
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555	555	555	555
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	828	828	828	828	828
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.19	0.19	0.19	0.19	0.19
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.06	0.06	0.06	0.06	0.06
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.69	0.69	0.69	0.69	0.69
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.06	0.06	0.06	0.06	0.06
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42	42	42	42
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42	42	42	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8	0.93	0.93
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8	0.8	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	1	1	1	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	1	1	1	1
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2	2	2	1
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98	98	98	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-28 Specific-to-Farm Factors, Oregon Wheat 3600

Parameter	Description	Unit	Winter wheat	Spring wheat	CRP
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.714	1.714	1.714
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0696	0.0696	0.0696
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	539	539	539
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	887	887	887
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	955	955	955
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.00	0.00	0.00
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.28	0.28	0.28
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.06	0.06	0.06
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.01	0.01	0.01
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.06	0.06	0.06
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.58	0.58	0.58
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42	42
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.93
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1.1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	1	1.07
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	1	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-29 Specific-to-Farm Factors, Washington Colorado Wheat 3000

Parameter	Description	Unit	Winter wheat	Millet	Corn	CRP
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.628	1.628	1.628	1.628
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0815	0.0815	0.0815	0.0815
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	458	458	458	458
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	1100	1100	1100	1100
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	893	893	893	893
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.00	0.00	0.00	0.00
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.27	0.27	0.27	0.27
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.63	0.63	0.63	0.63
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.06	0.06	0.06	0.06
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.04	0.04	0.04	0.04
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42	42	42
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42	42	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8	0.93
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1	1.1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	1	1	1.07
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	1	1	1.07

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-30 Specific-to-Farm Factors, Washington Colorado Wheat 5640

Parameter	Description	Unit	Winter wheat	Millet	Corn	CRP
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.628	1.628	1.628	1.628
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0815	0.0815	0.0815	0.0815
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	458	458	458	458
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	1100	1100	1100	1100
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	893	893	893	893
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.00	0.00	0.00	0.00
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.27	0.27	0.27	0.27
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.63	0.63	0.63	0.63
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.06	0.06	0.06	0.06
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.04	0.04	0.04	0.04
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42	42	42
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42	42	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8	0.93
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.1	1.1	1.1	1.1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1.02	1.02	1.02	1.02
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	1	1	1.07
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	1	1	1.07

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-31 Specific-to-Farm Factors, Washington Wheat 1725

Parameter	Description	Unit	Winter wheat	Barley	Peas	Spring wheat
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.714	1.714	1.714	1.714
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0696	0.0696	0.0696	0.0696
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	539	539	539	539
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	887	887	887	887
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	955	955	955	955
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.06	0.06	0.06	0.06
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.11	0.11	0.11	0.11
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.07	0.07	0.07	0.07
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.01	0.01	0.01	0.01
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.03	0.03	0.03	0.03
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.70	0.70	0.70	0.70
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42	42	42
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42	42	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8	0.8
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	1	1	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	1	1	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-32 Specific-to-Farm Factors, Washington Wheat 5500

Parameter	Description	Unit	Winter wheat	Barley	Peas and lentils	Spring wheat	Fallow	CRP
$Price_{diesel,2009}$ [a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.714	1.714	1.714	1.714	1.714	1.71
$Price_{electricity,2009}$ [b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0696	0.0696	0.07	0.0696	0.07	0.07
$fertPrice_{Ammonium\ Nitrate,2009}$ [a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	539	539	539	539	539	539
$fertPrice_{Phosphoric\ Acid,2009}$ [a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	887	887	887	887	887	887
$fertPrice_{Potash,2009}$ [a]	price of K_2O in 2009	U.S. dollars ton^{-1}	955	955	955	955	955	955
$herbPrice_{atrazine,2009}$ [a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$ [a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$ [b]	proportion of electricity from nuclear fission	index	0.06	0.06	0.06	0.06	0.06	0.06
$Prop_{NG}$ [b]	proportion of electricity from natural gas	index	0.11	0.11	0.11	0.11	0.11	0.11
$Prop_{CL}$ [b]	proportion of electricity from coal	index	0.07	0.07	0.07	0.07	0.07	0.07
$Prop_{WB}$ [b]	proportion of electricity from woody biomass	index	0.01	0.01	0.01	0.01	0.01	0.01
$Prop_{HB}$ [b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$ [b]	proportion of electricity from with wind	index	0.03	0.03	0.03	0.03	0.03	0.03
$Prop_{HE}$ [b]	proportion of electricity from hydroelectric dams	index	0.70	0.70	0.70	0.70	0.70	0.70
$SOC_{Ref,Z,0}$ [c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42	42	42	42	42
$SOC_{Ref,Z,0-t}$ [c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42	42	42	42	42
$F_{Lu,Z,0}$ [c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8	0.8	0.93	0.8
$F_{Lu,Z,0-t}$ [c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8	0.8	0.8	0.8
$F_{Mg,Z,0}$ [c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1	1	1.1	1.1
$F_{Mg,Z,0-t}$ [c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1	1	1	1
$F_{O,Z,0}$ [c]	SOC scaling factor-residues at beginning of the period	index	1	1	1	1	1.07	1
$F_{O,Z,0-t}$ [c]	SOC scaling factor-residues at end of the period	index	1	1	1	1	1	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-33 Specific-to-Farm Factors, Desha Arkansas Rice 7500

Parameter	Description	Unit	Flooded rice	Irrigated FS soybean	Irrigated double crop soybean	Irrigated corn	Winter wheat	Irrigated cotton
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.602	1.602	1.602	1.602	1.602	1.602
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0756	0.0756	0.0756	0.076	0.0756	0.0756
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441	441	441	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841	841	841	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.26	0.26	0.26	0.26	0.26	0.26
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.20	0.20	0.20	0.20	0.20	0.20
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.44	0.44	0.44	0.44	0.44	0.44
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.03	0.03	0.03	0.03	0.03	0.03
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.07	0.07	0.07	0.07	0.07	0.07
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51	51	51	51	51
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51	51	51	51	51
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	1.1	0.69	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	1.1	0.69	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	0	1	1	1	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	0	1	1	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0	0.94	0.94	1	1	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0	0.94	0.94	1	1	0.94
EF_{rice}[d]	CH_4 emission factor-flooded rice	kg CH_4 ha^{-1} day^{-1}	1.3	1.3	1.3	1.3	1.3	1.3
$SF_{cult,Z,T}$[d]	EF_{rice} scaling factor-water regime during cultivation period	index	1	0	0	0	0	0
$SF_{prev,Z,T}$[d]	EF_{rice} scaling factor-water regime before cultivation period	index	1	1	1	1	1	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-34 Specific-to-Farm Factors, Butte California Rice 1300

Parameter	Description	Unit	Flooded rice
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.714
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.1342
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	458
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	1100
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	893
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.16
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.55
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.01
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.02
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.01
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.03
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.14
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	65
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	65
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	1.1
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	1.1
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94
EF_{rice}[d]	CH_4 emission factor-flooded rice	kg CH_4 ha^{-1} day^{-1}	1.3
$SF_{cult,Z,T}$[d]	EF_{rice} scaling factor-water regime during cultivation period	index	1
$SF_{prev,Z,T}$[d]	EF_{rice} scaling factor-water regime before cultivation period	index	0.68

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-35 Specific-to-Farm Factors, Colusa California Rice 800

Parameter	Description	Unit	Flooded rice
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.714
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.1342
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	458
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	1100
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	893
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.16
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.55
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.01
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.02
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.01
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.03
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.14
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	65
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	65
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	1.1
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	1.1
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94
EF_{rice}[d]	CH_4 emission factor-flooded rice	kg CH_4 ha^{-1} day^{-1}	1.3
$SF_{cult,Z,T}$[d]	EF_{rice} scaling factor-water regime during cultivation period	index	1
$SF_{prev,Z,T}$[d]	EF_{rice} scaling factor-water regime before cultivation period	index	0.68

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-36 Specific-to-Farm Factors, Hoxie Arkansas Rice 3000

Parameter	Description	Unit	Flooded medium grain rice	Flooded long grain rice	Irrigated soybean	Soybean	Irrigated corn
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.602	1.602	1.602	1.602	1.602
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0756	0.0756	0.0756	0.0756	0.0756
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441	441	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841	841	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.26	0.26	0.26	0.26	0.26
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.20	0.20	0.20	0.20	0.20
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.44	0.44	0.44	0.44	0.44
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.03	0.03	0.03	0.03	0.03
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.00	0.00	0.00	0.00	0.00
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.07	0.07	0.07	0.07	0.07
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51	51	51	51
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51	51	51	51
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	1.1	1.1	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	1.1	1.1	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1.15	1	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1.08	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	0.94	0.94	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	0.94	0.94	1
EF_{rice}[d]	CH_4 emission factor-flooded rice	kg CH_4 ha^{-1} day^{-1}	1.3	1.3	1.3	1.3	1.3
$SF_{cult,Z,T}$[d]	EF_{rice} scaling factor-water regime during cultivation period	index	1	1	1	1	1
$SF_{prev,Z,T}$[d]	EF_{rice} scaling factor-water regime before cultivation period	index	0.68	0.68	0.68	0.68	0.68

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-37 Specific-to-Farm Factors, Butler Missouri Rice

Parameter	Description	Unit	Flooded rice	Irrigated soybean
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.675	1.675
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0696	0.0696
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	406	406
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	848	848
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.12	0.12
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.04	0.04
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.81	0.81
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.01	0.01
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.02	0.02
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	1.1	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	1.1	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94
EF_{rice}[d]	CH_4 emission factor-flooded rice	kg CH_4 ha^{-1} day^{-1}	1.3	1.3
$SF_{cult,Z,T}$[d]	EF_{rice} scaling factor-water regime during cultivation period	index	1	1
$SF_{prev,Z,T}$[d]	EF_{rice} scaling factor-water regime before cultivation period	index	0.68	0.68

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-38 Specific-to-Farm Factors, Richland Parish Louisiana Rice 2500

Parameter	Description	Unit	Flooded rice	Soybean	Irrigated soybean	Irrigated cotton	Cotton	Sorghum	Corn	Irrigated corn
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.602	1.602	1.602	1.602	1.602	1.602	1.602	1.602
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0769	0.0769	0.0769	0.0769	0.0769	0.0769	0.0769	0.0769
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	440	440	440	440	440	440	440	440
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	664	664	664	664	664	664	664	664
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	838	838	838	838	838	838	838	838
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51	51	51	51	51	51	51
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51	51	51	51	51	51	51
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	1.1	0.69	0.69	0.69	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	1.1	0.69	0.69	0.69	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	0	1	1	1	1	1	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	0	1	1	1	1	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0	0.94	0.94	0.94	0.94	1	1	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0	0.94	0.94	0.94	0.94	1	1	1
EF_{rice}[d]	CH_4 emission factor-flooded rice	kg CH_4 ha^{-1} day^{-1}	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
$SF_{cult,Z,T}$[d]	EF_{rice} scaling factor-water regime during cultivation period	index	1	1	1	1	1	1	1	1
$SF_{prev,Z,T}$[d]	EF_{rice} scaling factor-water regime before cultivation period	index	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-39 Specific-to-Farm Factors, Acadia Parish Louisiana Rice 1200

Parameter	Description	Unit	Flooded rice	Soybean	Crawfish
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.602	1.602	1.602
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0769	0.0769	0.0769
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	440	440	440
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	664	664	664
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	838	838	838
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.18	0.18	0.18
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.48	0.48	0.48
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.25	0.25	0.25
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.03	0.03	0.03
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.00	0.00	0.00
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.01	0.01	0.01
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51	51
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51	51
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	1.1	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	1.1	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	1	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	1	0.94
EF_{rice}[d]	CH_4 emission factor-flooded rice	kg CH_4 ha^{-1} day^{-1}	1.3	1.3	1.3
$SF_{cult,Z,T}$[d]	EF_{rice} scaling factor-water regime during cultivation period	index	1	1	1
$SF_{prev,Z,T}$[d]	EF_{rice} scaling factor-water regime before cultivation period	index	0.68	0.68	0.68

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-40 Specific-to-Farm Factors, Stuttgart Arkansas Rice 3240

Parameter	Description	Unit	Flooded rice	Winter wheat	Irrigated soybean	Irrigated double crop soybean
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.602	1.602	1.602	1.602
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0756	0.0756	0.0756	0.0756
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.26	0.26	0.26	0.26
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.20	0.20	0.20	0.20
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.44	0.44	0.44	0.44
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.03	0.03	0.03	0.03
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.00	0.00	0.00	0.00
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.07	0.07	0.07	0.07
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51	51	51
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51	51	51
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	1.1	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	1.1	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	0	1.15	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	0	1.08	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0	1	0.94	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0	1	0.94	0.94
EF_{rice}[d]	CH_4 emission factor-flooded rice	kg CH_4 ha^{-1} day^{-1}	1.3	1.3	1.3	1.3
$SF_{cult,Z,T}$[d]	EF_{rice} scaling factor-water regime during cultivation period	index	1	1	1	1
$SF_{prev,Z,T}$[d]	EF_{rice} scaling factor-water regime before cultivation period	index	0.68	0.68	0.68	0.68

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-41 Specific-to-Farm Factors, Sutter California Rice 550

Parameter	Description	Unit	Flooded rice
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.714
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.1342
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	458
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	1100
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	893
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.16
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.55
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.01
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.02
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.01
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.03
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.14
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	65
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	65
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	1.1
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	1.1
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94
EF_{rice}[d]	CH_4 emission factor-flooded rice	kg CH_4 ha^{-1} day^{-1}	1.3
$SF_{cult,Z,T}$[d]	EF_{rice} scaling factor-water regime during cultivation period	index	1
$SF_{prev,Z,T}$[d]	EF_{rice} scaling factor-water regime before cultivation period	index	0.68

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-42 Specific-to-Farm Factors, Sutter California Rice 3000

Parameter	Description	Unit	Flooded rice
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.714
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.1342
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	458
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	1100
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	893
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.16
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.55
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.01
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.02
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.01
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.03
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.14
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	65
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	65
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	1.1
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	1.1
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94
EF_{rice}[d]	CH_4 emission factor-flooded rice	kg CH_4 ha^{-1} day^{-1}	1.3
$SF_{cult,Z,T}$[d]	EF_{rice} scaling factor-water regime during cultivation period	index	1
$SF_{prev,Z,T}$[d]	EF_{rice} scaling factor-water regime before cultivation period	index	0.68

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-43 Specific-to-Farm Factors, Bay City Texas Rice 1800

Parameter	Description	Unit	Flooded rice
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.10
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.48
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.35
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.05
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	1.1
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	1.1
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94
EF_{rice}[d]	CH_4 emission factor-flooded rice	kg CH_4 ha^{-1} day^{-1}	1.3
$SF_{cult,Z,T}$[d]	EF_{rice} scaling factor-water regime during cultivation period	index	1
$SF_{prev,Z,T}$[d]	EF_{rice} scaling factor-water regime before cultivation period	index	0.68

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-44 Specific-to-Farm Factors, Eagle Lake Texas Rice 1350

Parameter	Description	Unit	Flooded rice
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.10
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.48
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.35
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.05
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	37
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	37
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	1.1
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	1.1
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94
EF_{rice}[d]	CH_4 emission factor-flooded rice	kg CH_4 ha^{-1} day^{-1}	1.3
$SF_{cult,Z,T}$[d]	EF_{rice} scaling factor-water regime during cultivation period	index	1
$SF_{prev,Z,T}$[d]	EF_{rice} scaling factor-water regime before cultivation period	index	0.68

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-45 Specific-to-Farm Factors, Eagle Lake Texas Rice 3000

Parameter	Description	Unit	Flooded rice
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.10
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.48
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.35
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.05
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	37
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	37
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	1.1
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	1.1
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94
EF_{rice}[d]	CH_4 emission factor-flooded rice	kg CH_4 ha^{-1} day^{-1}	1.3
$SF_{cult,Z,T}$[d]	EF_{rice} scaling factor-water regime during cultivation period	index	1
$SF_{prev,Z,T}$[d]	EF_{rice} scaling factor-water regime before cultivation period	index	0.68

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-46 Specific-to-Farm Factors, El Camp Texas Rice 3200

Parameter	Description	Unit	Flooded rice	Sorghum	Soybean
$Price_{diesel,2009}$ [a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725	1.725	1.725
$Price_{electricity,2009}$ [b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0966	0.0966	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}$ [a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$ [a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441
$fertPrice_{Potash,2009}$ [a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841
$herbPrice_{atrazine,2009}$ [a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$ [a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5
$Prop_{NF}$ [b]	proportion of electricity from nuclear fission	index	0.10	0.10	0.10
$Prop_{NG}$ [b]	proportion of electricity from natural gas	index	0.48	0.48	0.48
$Prop_{CL}$ [b]	proportion of electricity from coal	index	0.35	0.35	0.35
$Prop_{WB}$ [b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00
$Prop_{HB}$ [b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00
$Prop_{WND}$ [b]	proportion of electricity from with wind	index	0.05	0.05	0.05
$Prop_{HE}$ [b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00
$SOC_{Ref,Z,0}$ [c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	37	37	37
$SOC_{Ref,Z,0-t}$ [c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	37	37	37
$F_{Lu,Z,0}$ [c]	SOC scaling factor-land use at beginning of the study period	index	1.1	0.8	0.8
$F_{Lu,Z,0-t}$ [c]	SOC scaling factor- land use at end of the study period	index	1.1	0.8	0.8
$F_{Mg,Z,0}$ [c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1
$F_{Mg,Z,0-t}$ [c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1
$F_{O,Z,0}$ [c]	SOC scaling factor-residues at beginning of the period	index	0.94	1	0.94
$F_{O,Z,0-t}$ [c]	SOC scaling factor-residues at end of the period	index	0.94	1	0.94
EF_{rice} [d]	CH_4 emission factor-flooded rice	kg CH_4 ha^{-1} day^{-1}	1.3	1.3	1.3
$SF_{cult,Z,T}$ [d]	EF_{rice} scaling factor-water regime during cultivation period	index	1	1	1
$SF_{prev,Z,T}$ [d]	EF_{rice} scaling factor-water regime before cultivation period	index	0.68	0.68	0.68

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-47 Specific-to-Farm Factors, Wynne Arkansas Rice 1400

Parameter	Description	Unit	Flooded rice	Irrigated soybean	Soybean
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.602	1.602	1.602
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0756	0.0756	0.0756
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.26	0.26	0.26
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.20	0.20	0.20
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.44	0.44	0.44
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.03	0.03	0.03
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.00	0.00	0.00
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.07	0.07	0.07
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51	51
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51	51
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	1.1	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	1.1	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1.15	1.15
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-management tillage practices at the end of the period	index	1	1.08	1.08
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	1	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	1	1
EF_{rice}[d]	CH_4 emission factor-flooded rice	kg CH_4 ha^{-1} day^{-1}	1.3	1.3	1.3
$SF_{cult,Z,T}$[d]	EF_{rice} scaling factor-water regime during cultivation period	index	1	1	1
$SF_{prev,Z,T}$[d]	EF_{rice} scaling factor-water regime before cultivation period	index	0.68	0.68	0.68

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-48 Specific-to-Farm Factors, Alabama Cotton 3000

Parameter	Description	Unit	Irrigated cotton	Cotton	Corn	Irrigated corn	Soybean	Dry bean	Winter wheat
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.66	1.66	1.66	1.664	1.66	1.66	1.664
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.1	0.1	0.1	0.1005	0.1	0.1	0.101
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	440	440	440	440	440	440	440
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	664	664	664	664	664	664	664
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	838	838	838	838	838	838	838
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.28	0.28	0.28	0.28	0.28	0.28	0.28
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.22	0.22	0.22	0.22	0.22	0.22	0.22
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.35	0.35	0.35	0.35	0.35	0.35	0.35
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.02	0.02	0.02	0.02	0.02	0.02	0.02
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.09	0.09	0.09	0.09	0.09	0.09	0.09
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	40	40	40	40	40	40	40
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	40	40	40	40	40	40	40
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.15	1.15	1.15	1.15	1.15	1.15	1.15
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1.08	1.08	1.08	1.08	1.08	1.08	1.08
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	1	1	0.94	0.94	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	1	1	0.94	0.94	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-49 Specific-to-Farm Factors, California Cotton 4000

Parameter	Description	Unit	Irrigated cotton	Irrigated Pima cotton	Irrigated wheat silage	Irrigate d corn silage	Irrigated alfalfa establishment	Irrigated Alfalfa	Irrigated almonds	Irrigate d winter wheat
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.714	1.714	1.714	1.714	1.714	1.714	1.714	1.714
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.1342	0.1342	0.1342	0.134	0.1342	0.134	0.1342	0.134
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	539	539	539	539	539	539	539	539
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	1100	1100	1100	1100	1100	1100	1100	1100
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	955	955	955	955	955	955	955	955
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51	51	51	51	51	51	51
$SOC_{Ref,Z,0\text{-}t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51	51	51	51	51	51	51
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
$F_{Lu,Z,0\text{-}t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1.08	1	1	1.15	1.15	1
$F_{Mg,Z,0\text{-}t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1	1	1	1	1.08	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	0.94	0.94	0.94	0.94	0	1
$F_{O,Z,0\text{-}t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	0.94	0.94	0.94	0.94	0	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-50 Specific-to-Farm Factors, Louisiana Cotton 2640

Parameter	Description	Unit	Irrigated	Cotton	Irrigated soybean	Irrigated corn	Corn
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.602	1.602	1.602	1.602	1.602
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0769	0.0769	0.0769	0.0769	0.0769
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	440	440	440	440	440
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	664	664	664	664	664
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	838	838	838	838	838
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.18	0.18	0.18	0.18	0.18
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.48	0.48	0.48	0.48	0.48
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.25	0.25	0.25	0.25	0.25
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.03	0.03	0.03	0.03	0.03
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.00	0.00	0.00	0.00	0.00
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.01	0.01	0.01	0.01	0.01
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51	51	51	51
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51	51	51	51
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	0.94	1	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	0.94	1	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-51 Specific-to-Farm Factors, North Carolina Cotton 1500

Parameter	Description	Unit	Cotton	Soybean	Winter wheat	Corn
$Price_{diesel,2009}$ [a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.745	1.745	1.745	1.745
$Price_{electricity,2009}$ [b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0798	0.0798	0.0798	0.0798
$fertPrice_{Ammonium\ Nitrate,2009}$ [a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	542	542	542	542
$fertPrice_{Phosphoric\ Acid,2009}$ [a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	904	904	904	904
$fertPrice_{Potash,2009}$ [a]	price of K_2O in 2009	U.S. dollars ton^{-1}	943	943	943	943
$herbPrice_{atrazine,2009}$ [a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$ [a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$ [b]	proportion of electricity from nuclear fission	index	0.34	0.34	0.34	0.34
$Prop_{NG}$ [b]	proportion of electricity from natural gas	index	0.04	0.04	0.04	0.04
$Prop_{CL}$ [b]	proportion of electricity from coal	index	0.55	0.55	0.55	0.55
$Prop_{WB}$ [b]	proportion of electricity from woody biomass	index	0.01	0.01	0.01	0.01
$Prop_{HB}$ [b]	proportion of electricity from herbaceous biomass	index	0.01	0.01	0.01	0.01
$Prop_{WND}$ [b]	proportion of electricity from with wind	index	0.00	0.00	0.00	0.00
$Prop_{HE}$ [b]	proportion of electricity from hydroelectric dams	index	0.04	0.04	0.04	0.04
$SOC_{Ref,Z,0}$ [c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	40	40	40	40
$SOC_{Ref,Z,0-t}$ [c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	40	40	40	40
$F_{Lu,Z,0}$ [c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$ [c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$ [c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1	1
$F_{Mg,Z,0-t}$ [c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1	1
$F_{O,Z,0}$ [c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	1	1
$F_{O,Z,0-t}$ [c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	1	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-52 Specific-to-Farm Factors, Northeast Arkansas Cotton 5000

Parameter	Description	Unit	Irrigated cotton	Cotton
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.602	1.602
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0756	0.0756
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.26	0.26
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.20	0.20
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.44	0.44
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.03	0.03
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.00	0.00
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.07	0.07
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-53 Specific-to-Farm Factors, Southwest Georgia Cotton 2300

Parameter	Description	Unit	Irrigated cotton	Cotton	Irrigated corn	Irrigated peanut	Peanut
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.664	1.664	1.664	1.664	1.664
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0894	0.0894	0.0894	0.089	0.089
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	542	542	542	542	542
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	904	904	904	904	904
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	943	943	943	943	943
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.25	0.25	0.25	0.25	0.25
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.16	0.16	0.16	0.16	0.16
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.54	0.54	0.54	0.54	0.54
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.02	0.02	0.02	0.02	0.02
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.00	0.00	0.00	0.00	0.00
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.03	0.03	0.03	0.03	0.03
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	40	40	40	40	40
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	40	40	40	40	40
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	1	1	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	1	1	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-54 Specific-to-Farm Factors, Tennessee Cotton 2100

Parameter	Description	Unit	Cotton	Soybean	Corn	CRP
$Price_{diesel,2009}$ [a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.745	1.745	1.745	1.745
$Price_{electricity,2009}$ [b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0961	0.0961	0.0961	0.0961
$fertPrice_{Ammonium\ Nitrate,2009}$ [a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	440	440	440	440
$fertPrice_{Phosphoric\ Acid,2009}$ [a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	664	664	664	664
$fertPrice_{Potash,2009}$ [a]	price of K_2O in 2009	U.S. dollars ton^{-1}	838	838	838	838
$herbPrice_{atrazine,2009}$ [a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$ [a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$ [b]	proportion of electricity from nuclear fission	index	0.34	0.34	0.34	0.34
$Prop_{NG}$ [b]	proportion of electricity from natural gas	index	0.01	0.01	0.01	0.01
$Prop_{CL}$ [b]	proportion of electricity from coal	index	0.52	0.52	0.52	0.52
$Prop_{WB}$ [b]	proportion of electricity from woody biomass	index	0.01	0.01	0.01	0.01
$Prop_{HB}$ [b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00
$Prop_{WND}$ [b]	proportion of electricity from with wind	index	0.00	0.00	0.00	0.00
$Prop_{HE}$ [b]	proportion of electricity from hydroelectric dams	index	0.13	0.13	0.13	0.13
$SOC_{Ref,Z,0}$ [c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51	51	51
$SOC_{Ref,Z,0-t}$ [c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51	51	51
$F_{Lu,Z,0}$ [c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.82
$F_{Lu,Z,0-t}$ [c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$ [c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.15	1.15	1.15	1.15
$F_{Mg,Z,0-t}$ [c]	SOC scaling factor-tillage practices at the end of the period	index	1.08	1.08	1.08	1.15
$F_{O,Z,0}$ [c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	1	1.07
$F_{O,Z,0-t}$ [c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	1	1.07

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-55 Specific-to-Farm Factors, Tennessee Cotton 4050

Parameter	Description	Unit	Cotton	Soybean	Corn	Double crop winter wheat	Double crop soybeans
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.745	1.745	1.745	1.745	1.745
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.096	0.0961	0.0961	0.0961	0.0961
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	440	440	440	440	440
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	664	664	664	664	664
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	838	838	838	838	838
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.34	0.34	0.34	0.34	0.34
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.01	0.01	0.01	0.01	0.01
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.52	0.52	0.52	0.52	0.52
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.01	0.01	0.01	0.01	0.01
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.00	0.00	0.00	0.00	0.00
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.13	0.13	0.13	0.13	0.13
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51	51	51	51
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51	51	51	51
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.15	1.15	1.15	1.15	1.15
$F_{Mg,Z,0-t}$[c]	SOC scaling factor- tillage practices at the end of the period	index	1.08	1.08	1.08	1.08	1.08
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	1	1	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	1	1	0.94

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-56 Specific-to-Farm Factors, Texas Coastal Bend Cotton and Grain 2250

Parameter	Description	Unit	Sorghum	Cotton	Corn
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725	1.725	1.725
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0966	0.0966	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.10	0.10	0.10
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.01	0.01	0.01
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.35	0.35	0.35
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.05	0.05	0.05
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42	42
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	0.94	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	0.94	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-57 Specific-to-Farm Factors, Texas Eastern Caprock Cotton 5000

Parameter	Description	Unit	Cotton	Irrigated cotton	Irrigated sorghum	Winter wheat	Sorghum
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725	1.725	1.725	1.725	1.725
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0966	0.0966	0.0966	0.0966	0.097
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441	441	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841	841	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.10	0.10	0.10	0.10	0.10
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.01	0.01	0.01	0.01	0.01
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.35	0.35	0.35	0.35	0.35
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.05	0.05	0.05	0.05	0.05
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42	42	42	42
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42	42	42	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8	0.8	0.8
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8	0.8	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-management tillage practices at the end of the period	index	1	1	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	1	1	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	1	1	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-58 Specific-to-Farm Factors, Texas Midcoast Cotton and Grain 1800

Parameter	Description	Unit	Sorghum	Cotton	Corn	Soybean
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725	1.725	1.725	1.725
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0966	0.0966	0.0966	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.10	0.10	0.10	0.10
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.01	0.01	0.01	0.01
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.35	0.35	0.35	0.35
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.05	0.05	0.05	0.05
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42	42	42
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42	42	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.58	0.58	0.58	0.58
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.58	0.58	0.58	0.58
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	0.94	1	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	0.94	1	0.94

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-59 Specific-to-Farm Factors, Texas Panhandle Cotton and Grain 1800

Parameter	Description	Unit	Irrigated corn	Sorghum	Irrigated cotton	Winter wheat	Irrigated winter wheat
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725	1.725	1.725	1.725	1.725
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0966	0.0966	0.0966	0.0966	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441	441	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841	841	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.10	0.10	0.10	0.10	0.10
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.01	0.01	0.01	0.01	0.01
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.35	0.35	0.35	0.35	0.35
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.05	0.05	0.05	0.05	0.05
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	37	37	37	37	37
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	37	37	37	37	37
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.58	0.58	0.58	0.58	0.58
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.58	0.58	0.58	0.58	0.58
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.1	1.1	1.1	1.1	1.1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-management tillage practices at the end of the period	index	1.02	1.02	1.02	1.02	1.02
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	1	0.94	1	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	1	0.94	1	0.94

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-60 Specific-to-Farm Factors, Texas Rio Grande Valley Cotton 4500

Parameter	Description	Unit	Sorghum	Irrigated cotton	Cotton	Sugar cane
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725	1.725	1.725	1.725
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0966	0.0966	0.0966	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.10	0.10	0.10	0.10
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.01	0.01	0.01	0.01
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.35	0.35	0.35	0.35
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.05	0.05	0.05	0.05
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42	42	42
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42	42	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8	0.8
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	0.94	0.94	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	0.94	0.94	0.94

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-61 Specific-to-Farm Factors, Texas Rolling Plains Cotton 2500

Parameter	Description	Unit	Cotton
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.10
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.01
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.35
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.05
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.58
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.58
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-62 Specific-to-Farm Factors, Texas Southern Plains Cotton 2500

Parameter	Description	Unit	Cotton	Irrigated cotton	Irrigated peanut	Peanut	Irrigated winter wheat	Irrigated sorghum	Sorghum
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725	1.725	1.725	1.725	1.725	1.725	1.725
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0966	0.0966	0.0966	0.0966	0.0966	0.0966	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361	361	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441	441	441	441	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841	841	841	841	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.10	0.10	0.10	0.10	0.10	0.10	0.10
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.01	0.01	0.01	0.01	0.01	0.01	0.01
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.35	0.35	0.35	0.35	0.35	0.35	0.35
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.05	0.05	0.05	0.05	0.05	0.05	0.05
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	37	37	37	37	37	37	37
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	37	37	37	37	37	37	37
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1	1.1	1	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1	1.02	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	1	0.94	1	1	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	1	0.94	1	1	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-63 Specific-to-Farm Factors, Texas Southern Plains Cotton 4500

Parameter	Description	Unit	Cotton	Irrigated cotton	Irrigated Peanut	CRP	Irrigated winter wheat
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.73	1.725	1.725	1.725	1.725
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.1	0.097	0.0966	0.0966	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441	441	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841	841	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.10	0.10	0.10	0.10	0.10
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.01	0.01	0.01	0.01	0.01
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.35	0.35	0.35	0.35	0.35
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.05	0.05	0.05	0.05	0.05
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	37	37	37	37	37
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	37	37	37	37	37
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8	0.93	0.8
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8	0.8	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1	1.1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	1	0.94	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	1	0.94	1

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-64 Specific-to-Farm Factors, California Dairy 1710

Parameter	Description	Unit	Irrigated corn silage	Irrigated winter wheat silage	Dairy
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.714	1.714	1.714
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.1342	0.134	0.134
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	539	539	539
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	1100	1100	1100
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	955	955	955
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.16	0.16	0.16
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.55	0.55	0.55
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.01	0.01	0.01
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.02	0.02	0.02
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.01	0.01	0.01
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.03	0.03	0.03
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.14	0.14	0.14
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	37	37	37
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	37	37	37
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1.15	1.15
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1.08	1.15
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	0.94
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2	1
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98	48

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-65 Specific-to-Farm Factors, Central New York Dairy 110

Parameter	Description	Unit	Ground corn	Hay silage	Grass hay	Dairy
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.95	1.952	1.952	1.952
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.16	0.1551	0.155	0.1551
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	609	609	609	609
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	733	733	733	733
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	838	838	838	838
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.33	0.33	0.33	0.33
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.31	0.31	0.31	0.31
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.10	0.10	0.10	0.10
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.01	0.01	0.01	0.01
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.02	0.02	0.02	0.02
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.21	0.21	0.21	0.21
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	65	65	65	65
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	65	65	65	65
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1.15	1.15	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1.15	1.15	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	0.94	0.94	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	0.94	0.94	0.94
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2	2	1
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98	98	48

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-66 Specific-to-Farm Factors, Central New York Dairy 550

Parameter	Description	Unit	Corn silage	Alfalfa hay silage	Dairy
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.952	1.952	1.952
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.1551	0.1551	0.1551
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	609	609	609
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	733	733	733
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	838	838	838
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.33	0.33	0.33
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.31	0.31	0.31
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.10	0.10	0.10
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.01	0.01	0.01
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.02	0.02	0.02
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.21	0.21	0.21
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	65	65	65
$SOC_{Ref,Z,0\text{-}t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	65	65	65
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69
$F_{Lu,Z,0\text{-}t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1.15	1
$F_{Mg,Z,0\text{-}t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1.15	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	0.94
$F_{O,Z,0\text{-}t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	0.94
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2	1
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98	48

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-67 Specific-to-Farm Factors, Central Texas Dairy 550

Parameter	Description	Unit	Coastal hay	Green cut wheat	Sorghum silage	Dairy
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725	1.725	1.725	1.725
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.097	0.0966	0.097	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.10	0.10	0.10	0.10
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.48	0.48	0.48	0.48
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.35	0.35	0.35	0.35
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.05	0.05	0.05	0.05
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51	51	51
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51	51	51
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.15	1	1	1.15
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-management tillage practices at the end of the period	index	1.15	1	1	1.15
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	0.94	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	0.94	0.94
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2	2	2
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98	98	68

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-68 Specific-to-Farm Factors, Central Texas Dairy 1300

Parameter	Description	Unit	Wheat silage	Dairy
$Price_{diesel,2009}$ [a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725	1.725
$Price_{electricity,2009}$ [b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0966	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}$ [a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361
$fertPrice_{Phosphoric\ Acid,2009}$ [a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441
$fertPrice_{Potash,2009}$ [a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841
$herbPrice_{atrazine,2009}$ [a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$ [a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5
$Prop_{NF}$ [b]	proportion of electricity from nuclear fission	index	0.10	0.10
$Prop_{NG}$ [b]	proportion of electricity from natural gas	index	0.48	0.48
$Prop_{CL}$ [b]	proportion of electricity from coal	index	0.35	0.35
$Prop_{WB}$ [b]	proportion of electricity from woody biomass	index	0.00	0.00
$Prop_{HB}$ [b]	proportion of electricity from herbaceous biomass	index	0.00	0.00
$Prop_{WND}$ [b]	proportion of electricity from with wind	index	0.05	0.05
$Prop_{HE}$ [b]	proportion of electricity from hydroelectric dams	index	0.00	0.00
$SOC_{Ref,Z,0}$ [c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51
$SOC_{Ref,Z,0-t}$ [c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51
$F_{Lu,Z,0}$ [c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69
$F_{Lu,Z,0-t}$ [c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69
$F_{Mq,Z,0}$ [c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1.15
$F_{Mg,Z,0-t}$ [c]	SOC scaling factor-tillage practices at the end of the period	index	1	1.15
$F_{O,Z,0}$ [c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94
$F_{O,Z,0-t}$ [c]	SOC scaling factor-residues at end of the period	index	0.94	0.94
$EF_{manure,ND,\tau}$ [d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2
$EF_{manure,D,\tau}$ [d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	68

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-69 Specific-to-Farm Factors, East Texas Dairy 400

Parameter	Description	Unit	Rye grass	Coastal hay	Dairy
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725	1.725	1.725
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0966	0.0966	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.10	0.10	0.10
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.48	0.48	0.48
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.35	0.35	0.35
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.05	0.05	0.05
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51	51
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51	51
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.15	1.15	1.15
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1.15	1.15	1.15
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	0.94
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2	2
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98	68

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-70 Specific-to-Farm Factors, East Texas Dairy 1000

Parameter	Description	Unit	Corn silage	Sorghum grain silage	Grass hay	Dairy
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725	1.725	1.725	1.725
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0966	0.0966	0.0966	0.097
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.10	0.10	0.10	0.10
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.48	0.48	0.48	0.48
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.35	0.35	0.35	0.35
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.05	0.05	0.05	0.05
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51	51	51
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51	51	51
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1.1	1.15
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1.1	1.15
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	0.94	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	0.94	0.94
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2	2	2
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98	98	68

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-71 Specific-to-Farm Factors, Missouri Grazing Dairy 550

Parameter	Description	Unit	Grass/legume	Corn silage	Double crop millet	Dairy
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.675	1.675	1.675	1.675
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0696	0.0696	0.0696	0.0696
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	406	406	406	406
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555	555	555
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	848	848	848	848
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.12	0.12	0.12	0.12
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.04	0.04	0.04	0.04
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.81	0.81	0.81	0.81
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.01	0.01	0.01	0.01
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.02	0.02	0.02	0.02
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	65	65	65	65
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	65	65	65	65
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.15	1	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1.15	1	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	0.94	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	0.94	0.94	0.94
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2	2	1
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98	98	55

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-72 Specific-to-Farm Factors, Nevada Dairy 500

Parameter	Description	Unit	Dry cow hay	Dairy
$Price_{diesel,2009}$ [a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.628	1.628
$Price_{electricity,2009}$ [b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.1064	0.1064
$fertPrice_{Ammonium\ Nitrate,2009}$ [a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	458	458
$fertPrice_{Phosphoric\ Acid,2009}$ [a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	887	887
$fertPrice_{Potash,2009}$ [a]	price of K_2O in 2009	U.S. dollars ton^{-1}	893	893
$herbPrice_{atrazine,2009}$ [a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$ [a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5
$Prop_{NF}$ [b]	proportion of electricity from nuclear fission	index	0.00	0.00
$Prop_{NG}$ [b]	proportion of electricity from natural gas	index	0.69	0.69
$Prop_{CL}$ [b]	proportion of electricity from coal	index	0.20	0.20
$Prop_{WB}$ [b]	proportion of electricity from woody biomass	index	0.00	0.00
$Prop_{HB}$ [b]	proportion of electricity from herbaceous biomass	index	0.00	0.00
$Prop_{WND}$ [b]	proportion of electricity from with wind	index	0.00	0.00
$Prop_{HE}$ [b]	proportion of electricity from hydroelectric dams	index	0.07	0.07
$SOC_{Ref,Z,0}$ [c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42
$SOC_{Ref,Z,0-t}$ [c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42
$F_{Lu,Z,0}$ [c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8
$F_{Lu,Z,0-t}$ [c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8
$F_{Mq,Z,0}$ [c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.15	1.15
$F_{Mg,Z,0-t}$ [c]	SOC scaling factor-tillage practices at the end of the period	index	1.15	1.15
$F_{O,Z,0}$ [c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94
$F_{O,Z,0-t}$ [c]	SOC scaling factor-residues at end of the period	index	0.94	0.94
$EF_{manure,ND,\tau}$ [d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	1
$EF_{manure,D,\tau}$ [d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98 50

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-73 Specific-to-Farm Factors, North Florida Dairy 550

Parameter	Description	Unit	Grass hay	Pasture	Irrigated corn silage	Irrigated rye grass	Dairy
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.664	1.664	1.664	1.664	1.664
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.1077	0.1077	0.1077	0.1077	0.1077
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	542	542	542	542	542
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	904	904	904	904	904
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	943	943	943	943	943
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.13	0.13	0.13	0.13	0.13
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.54	0.54	0.54	0.54	0.54
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.25	0.25	0.25	0.25	0.25
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.01	0.01	0.01	0.01	0.01
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.01	0.01	0.01	0.01	0.01
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.00	0.00	0.00	0.00	0.00
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	40	40	40	40	40
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	40	40	40	40	40
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.15	1.15	1	1.15	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1.15	1.15	1	1.15	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	0.94	1	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	0.94	1	0.94
$EF_{orgsoils,Z}$[d]	N emission factor for organic soils	kg N_2O-N ha^{-1} $year^{-1}$	8	8	8	8	8
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2	2	2	2
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98	98	98	78

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-74 Specific-to-Farm Factors, North Texas Dairy 3000

Parameter	Description	Unit	Sorghum silage	Winter wheat	Dairy
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725	1.725	1.725
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0966	0.0966	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.10	0.10	0.10
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.48	0.48	0.48
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.35	0.35	0.35
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.05	0.05	0.05
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51	51	51
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51	51	51
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1.15
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1	1.15
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	0.94
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2	2
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98	68

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-75 Specific-to-Farm Factors, South Florida Dairy 1500

Parameter	Description	Unit	Grass silage	Dairy
$Price_{diesel,2009}$ [a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.664	1.664
$Price_{electricity,2009}$ [b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.1077	0.1077
$fertPrice_{Ammonium\ Nitrate,2009}$ [a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	542	542
$fertPrice_{Phosphoric\ Acid,2009}$ [a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	904	904
$fertPrice_{Potash,2009}$ [a]	price of K_2O in 2009	U.S. dollars ton^{-1}	943	943
$herbPrice_{atrazine,2009}$ [a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$ [a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5
$Prop_{NF}$ [b]	proportion of electricity from nuclear fission	index	0.13	0.13
$Prop_{NG}$ [b]	proportion of electricity from natural gas	index	0.54	0.54
$Prop_{CL}$ [b]	proportion of electricity from coal	index	0.25	0.25
$Prop_{WB}$ [b]	proportion of electricity from woody biomass	index	0.01	0.01
$Prop_{HB}$ [b]	proportion of electricity from herbaceous biomass	index	0.01	0.01
$Prop_{WND}$ [b]	proportion of electricity from with wind	index	0.00	0.00
$Prop_{HE}$ [b]	proportion of electricity from hydroelectric dams	index	0.00	0.00
$SOC_{Ref,Z,0}$ [c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	86	86
$SOC_{Ref,Z,0-t}$ [c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	86	86
$F_{Lu,Z,0}$ [c]	SOC scaling factor-land use at beginning of the study period	index	0.48	0.48
$F_{Lu,Z,0-t}$ [c]	SOC scaling factor- land use at end of the study period	index	0.48	0.48
$F_{Mg,Z,0}$ [c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.22	1.15
$F_{Mg,Z,0-t}$ [c]	SOC scaling factor-tillage practices at the end of the period	index	1.22	1.15
$F_{O,Z,0}$ [c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94
$F_{O,Z,0-t}$ [c]	SOC scaling factor-residues at end of the period	index	0.94	0.94
$EF_{manure,ND,\tau}$ [d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	1
$EF_{manure,D,\tau}$ [d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	48

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-76 Specific-to-Farm Factors, Vermont Dairy 140

Parameter	Description	Unit	Mixed hay	Corn silage	Hay silage	Dairy
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.952	1.952	1.952	1.95
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.1293	0.1293	0.1293	0.13
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	609	609	609	609
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	733	733	733	733
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	838	838	838	838
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.74	0.74	0.74	0.74
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.00	0.00	0.00	0.00
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.00	0.00	0.00	0.00
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.05	0.05	0.05	0.05
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.00	0.00	0.00	0.00
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.20	0.20	0.20	0.20
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	74	74	74	74
$SOC_{Ref,Z,0\text{-}t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	74	74	74	74
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69
$F_{Lu,Z,0\text{-}t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.15	1	1.15	1
$F_{Mg,Z,0\text{-}t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1.15	1	1.15	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	0.94	0.94
$F_{O,Z,0\text{-}t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	0.94	0.94
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 head^{-1} year^{-1}	2	2	2	1
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 head^{-1} year^{-1}	98	98	98	48

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-77 Specific-to-Farm Factors, Vermont Dairy 400

Parameter	Description	Unit	Hay	Corn silage	Hay silage	Dairy
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.952	1.952	1.952	1.952
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.1293	0.1293	0.1293	0.129
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	609	609	609	609
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	733	733	733	733
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	838	838	838	838
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.74	0.74	0.74	0.74
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.00	0.00	0.00	0.00
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.00	0.00	0.00	0.00
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.05	0.05	0.05	0.05
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.00	0.00	0.00	0.00
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.20	0.20	0.20	0.20
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	74	74	74	74
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	74	74	74	74
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.15	1	1.15	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1.15	1	1.15	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	0.94	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	0.94	0.94
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2	2	1
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98	98	48

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-78 Specific-to-Farm Factors, Washington Dairy 250

Parameter	Description	Unit	Grass silage	Corn silage	Dairy
$Price_{diesel,2009}$ [a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.714	1.714	1.714
$Price_{electricity,2009}$ [b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0696	0.0696	0.0696
$fertPrice_{Ammonium\ Nitrate,2009}$ [a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	539	539	539
$fertPrice_{Phosphoric\ Acid,2009}$ [a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	887	887	887
$fertPrice_{Potash,2009}$ [a]	price of K_2O in 2009	U.S. dollars ton^{-1}	955	955	955
$herbPrice_{atrazine,2009}$ [a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$ [a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5
$Prop_{NF}$ [b]	proportion of electricity from nuclear fission	index	0.06	0.06	0.06
$Prop_{NG}$ [b]	proportion of electricity from natural gas	index	0.11	0.11	0.11
$Prop_{CL}$ [b]	proportion of electricity from coal	index	0.07	0.07	0.07
$Prop_{WB}$ [b]	proportion of electricity from woody biomass	index	0.01	0.01	0.01
$Prop_{HB}$ [b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00
$Prop_{WND}$ [b]	proportion of electricity from with wind	index	0.03	0.03	0.03
$Prop_{HE}$ [b]	proportion of electricity from hydroelectric dams	index	0.70	0.70	0.70
$SOC_{Ref,Z,0}$ [c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	114	114	114
$SOC_{Ref,Z,0-t}$ [c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	114	114	114
$F_{Lu,Z,0}$ [c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69
$F_{Lu,Z,0-t}$ [c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69
$F_{Mg,Z,0}$ [c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.15	1	1.15
$F_{Mg,Z,0-t}$ [c]	SOC scaling factor-tillage practices at the end of the period	index	1.15	1	1.15
$F_{O,Z,0}$ [c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	0.94
$F_{O,Z,0-t}$ [c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	0.94
$EF_{orgsoils,Z}$ [d]	N emission factor for organic soils	kg N_2O-N ha^{-1} $year^{-1}$	8	8	8
$EF_{manure,ND,\tau}$ [d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2	1
$EF_{manure,D,\tau}$ [d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98	50

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-79 Specific-to-Farm Factors, Washington Dairy 850

Parameter	Description	Unit	Grass silage	Dairy
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.714	1.714
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0696	0.0696
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	539	539
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	887	887
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	955	955
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.06	0.06
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.11	0.11
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.07	0.07
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.01	0.01
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.03	0.03
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.70	0.70
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	114	114
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	114	114
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1.15
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1.15
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	1
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	50

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-80 Specific-to-Farm Factors, Western New York Dairy 600

Parameter	Description	Unit	Corn silage	Alfalfa hay silage	Dairy
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.952	1.952	1.952
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.1551	0.1551	0.1551
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	609	609	609
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	733	733	733
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	838	838	838
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.33	0.33	0.33
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.31	0.31	0.31
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.10	0.10	0.10
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.01	0.01	0.01
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.02	0.02	0.02
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.21	0.21	0.21
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	65	65	65
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	65	65	65
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1.15	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1	1.15	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	0.94
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2	1
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98	48

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-81 Specific-to-Farm Factors, Western New York Dairy 1200

Parameter	Description	Unit	Corn silage	Dairy
$Price_{diesel,2009}$ [a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.952	1.95
$Price_{electricity,2009}$ [b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.1551	0.16
$fertPrice_{Ammonium\ Nitrate,2009}$ [a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	609	609
$fertPrice_{Phosphoric\ Acid,2009}$ [a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	733	733
$fertPrice_{Potash,2009}$ [a]	price of K_2O in 2009	U.S. dollars ton^{-1}	838	838
$herbPrice_{atrazine,2009}$ [a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$ [a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5
$Prop_{NF}$ [b]	proportion of electricity from nuclear fission	index	0.33	0.33
$Prop_{NG}$ [b]	proportion of electricity from natural gas	index	0.31	0.31
$Prop_{CL}$ [b]	proportion of electricity from coal	index	0.10	0.10
$Prop_{WB}$ [b]	proportion of electricity from woody biomass	index	0.00	0.00
$Prop_{HB}$ [b]	proportion of electricity from herbaceous biomass	index	0.01	0.01
$Prop_{WND}$ [b]	proportion of electricity from with wind	index	0.02	0.02
$Prop_{HE}$ [b]	proportion of electricity from hydroelectric dams	index	0.21	0.21
$SOC_{Ref,Z,0}$ [c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	65	65
$SOC_{Ref,Z,0-t}$ [c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	65	65
$F_{Lu,Z,0}$ [c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69
$F_{Lu,Z,0-t}$ [c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69
$F_{Mg,Z,0}$ [c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1.15
$F_{Mg,Z,0-t}$ [c]	SOC scaling factor-tillage practices at the end of the period	index	1	1.15
$F_{O,Z,0}$ [c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94
$F_{O,Z,0-t}$ [c]	SOC scaling factor-residues at end of the period	index	0.94	0.94
$EF_{orgsoils,Z}$ [d]	N emission factor for organic soils	kg N_2O-N ha^{-1} $year^{-1}$	8	8
$EF_{manure,ND,\tau}$ [d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	1
$EF_{manure,D,\tau}$ [d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	48

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-82 Specific-to-Farm Factors, Wisconsin Dairy 145

Parameter	Description	Unit	Alfalfa	Winter wheat	Corn silage	Corn	Alfalfa hay silage	Soybean	Dairy
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.688	1.688	1.688	1.688	1.688	1.688	1.688
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0957	0.0957	0.0957	0.096	0.096	0.096	0.096
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	406	406	406	406	406	406	406
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555	555	555	555	555	555
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	848	848	848	848	848	848	848
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.21	0.21	0.21	0.21	0.21	0.21	0.21
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.09	0.09	0.09	0.09	0.09	0.09	0.09
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.62	0.62	0.62	0.62	0.62	0.62	0.62
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.01	0.01	0.01	0.01	0.01	0.01	0.01
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.01	0.01	0.01	0.01	0.01	0.01	0.01
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.02	0.02	0.02	0.02	0.02	0.02	0.02
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.02	0.02	0.02	0.02	0.02	0.02	0.02
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	65	65	65	65	65	65	65
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	65	65	65	65	65	65	65
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.15	1	1	1	1.15	1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1.15	1	1	1	1.15	1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	1	0.94	1	0.94	0.94	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	1	0.94	1	0.94	0.94	0.94
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2	2	2	2	2	1
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98	98	98	98	98	48

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-83 Specific-to-Farm Factors, Wisconsin Dairy 1000

Parameter	Description	Unit	Winter wheat	Corn silage	Alfalfa hay silage	Corn	Soybean	Dairy
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.688	1.688	1.688	1.688	1.688	1.688
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.096	0.096	0.0957	0.0957	0.0957	0.0957
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	406	406	406	406	406	406
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555	555	555	555	555
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	848	848	848	848	848	848
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.21	0.21	0.21	0.21	0.21	0.21
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.09	0.09	0.09	0.09	0.09	0.09
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.62	0.62	0.62	0.62	0.62	0.62
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.01	0.01	0.01	0.01	0.01	0.01
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.01	0.01	0.01	0.01	0.01	0.01
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.02	0.02	0.02	0.02	0.02	0.02
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.02	0.02	0.02	0.02	0.02	0.02
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	65	65	65	65	65	65
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	65	65	65	65	65	65
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.15	1.15	1.15	1.15	1.15	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1.08	1.08	1.15	1.08	1.08	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	0.94	0.94	1	0.94	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	0.94	0.94	1	0.94	0.94
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2	2	2	2	1
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98	98	98	98	48

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-84 Specific-to-Farm Factors, California Cow-calf 500

Parameter	Description	Unit	Cow-calf
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.714
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.1342
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	539
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	1100
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	955
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.16
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.55
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.01
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.02
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.01
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.03
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.14
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	51
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	51
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	68

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-85 Specific-to-Farm Factors, Central Missouri Cow-calf 400

Parameter	Description	Unit	Pasture	Mixed hay	Alfalfa	Cow-calf
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.675	1.675	1.675	1.675
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0696	0.0696	0.0696	0.0696
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	406	406	406	406
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555	555	555
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	848	848	848	848
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.12	0.12	0.12	0.12
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.04	0.04	0.04	0.04
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.81	0.81	0.81	0.81
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.01	0.01	0.01	0.01
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.02	0.02	0.02	0.02
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	65	65	65	65
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	65	65	65	65
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.15	1.15	1.15	1.15
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1.15	1.15	1.15	1.08
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	0.94	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	0.94	1
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2	2	1
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98	98	55

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-86 Specific-to-Farm Factors, Colorado Cow-calf 250

Parameter	Description	Unit	Meadow hay	Cow-calf
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.628	1.628
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0815	0.0815
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	458	458
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	1100	1100
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	893	893
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.00	0.00
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.27	0.27
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.63	0.63
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.06	0.06
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.04	0.04
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.1	1.15
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1.1	1.08
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1	1
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	1
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	48

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-87 Specific-to-Farm Factors, Dade Missouri Cow-calf 250

Parameter	Description	Unit	Soybean	Double crop soybeans	Winter wheat	Fescue hay	Fescue pasture	Corn	Double crop fescue seed	Cow-calf
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.675	1.675	1.675	1.675	1.675	1.675	1.675	1.675
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0696	0.0696	0.0696	0.0696	0.0696	0.0696	0.0696	0.0696
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	406	406	406	406	406	406	406	406
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555	555	555	555	555	555	555
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	848	848	848	848	848	848	848	848
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8	20.8	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5	98.5	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	65	65	65	65	65	65	65	65
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	65	65	65	65	65	65	65	65
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1	1	1	1.15	1.15	1	1.15	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-management tillage practices at the end of the period	index	1	1	1	1.15	1.15	1	1.15	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	1	0.94	0.94	1	0.94	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	1	0.94	0.94	1	0.94	1
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2	2	2	2	2	2	1
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98	98	98	98	98	98	58

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-88 Specific-to-Farm Factors, Florida Cow-calf 1155

Parameter	Description	Unit	Improved pasture	Cow-calf
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.664	1.664
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.1077	0.1077
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	542	542
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	904	904
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	943	943
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.13	0.13
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.54	0.54
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.25	0.25
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.01	0.01
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.01	0.01
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.00	0.00
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	86	86
$SOC_{Ref,Z,0\text{-}t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	86	86
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.69	0.69
$F_{Lu,Z,0\text{-}t}$[c]	SOC scaling factor- land use at end of the study period	index	0.69	0.69
$F_{Mq,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.22	1.15
$F_{Mg,Z,0\text{-}t}$[c]	SOC scaling factor- tillage practices at the end of the period	index	1.22	1.08
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	1
$F_{O,Z,0\text{-}t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	1
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	85

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-89 Specific-to-Farm Factors, Montana Cow-calf 500

Parameter	Description	Unit	Alfalfa	Cow-calf
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.628	1.628
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0832	0.0832
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	458	458
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	1	1
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	893	893
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.00	0.00
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.00	0.00
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.58	0.58
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.03	0.03
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.36	0.36
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8
$F_{Mq,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.02	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1.02	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	1
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	1
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	48

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [b]Factors are from DOE (2010). [d]Factors are from Eggleston et al. (2006).

Table B-90 Specific-to-Farm Factors, Nevada Cow-calf 700

Parameter	Description	Unit	Meadow hay	Cow-calf
$Price_{diesel,2009}$ [a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.628	1.628
$Price_{electricity,2009}$ [b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.1064	0.1064
$fertPrice_{Ammonium\ Nitrate,2009}$ [a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	458	458
$fertPrice_{Phosphoric\ Acid,2009}$ [a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	1100	1100
$fertPrice_{Potash,2009}$ [a]	price of K_2O in 2009	U.S. dollars ton^{-1}	893	893
$herbPrice_{atrazine,2009}$ [a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$ [a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5
$Prop_{NF}$ [b]	proportion of electricity from nuclear fission	index	0.00	0.00
$Prop_{NG}$ [b]	proportion of electricity from natural gas	index	0.69	0.69
$Prop_{CL}$ [b]	proportion of electricity from coal	index	0.20	0.20
$Prop_{WB}$ [b]	proportion of electricity from woody biomass	index	0.00	0.00
$Prop_{HB}$ [b]	proportion of electricity from herbaceous biomass	index	0.00	0.00
$Prop_{WND}$ [b]	proportion of electricity from with wind	index	0.00	0.00
$Prop_{HE}$ [b]	proportion of electricity from hydroelectric dams	index	0.07	0.07
$SOC_{Ref,Z,0}$ [c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42
$SOC_{Ref,Z,0-t}$ [c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42
$F_{Lu,Z,0}$ [c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8
$F_{Lu,Z,0-t}$ [c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8
$F_{Mg,Z,0}$ [c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.1	1
$F_{Mg,Z,0-t}$ [c]	SOC scaling factor-tillage practices at the end of the period	index	1.1	1
$F_{O,Z,0}$ [c]	SOC scaling factor-residues at beginning of the period	index	0.94	1
$F_{O,Z,0-t}$ [c]	SOC scaling factor-residues at end of the period	index	0.94	1
$EF_{manure,ND,\tau}$ [d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	1
$EF_{manure,D,\tau}$ [d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	48

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-91 Specific-to-Farm Factors, New Mexico Cow-calf 240

Parameter	Description	Unit	Cow-calf
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.628
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.1064
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	458
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	1100
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	893
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.00
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.69
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.20
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.00
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.07
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor tillage practices at the end of the period	index	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	1
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	53

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-92 Specific-to-Farm Factors, South Dakota Cow-calf 375

Parameter	Description	Unit	Perennial hay	Annual hay	Cow-calf
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.66	1.66	1.66
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0714	0.0714	0.0714
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	400	400	400
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	555	555	555
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	828	828	828
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.00	0.00	0.00
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.01	0.01	0.01
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.00	0.00	0.00
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.05	0.05	0.05
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.54	0.54	0.54
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42	42
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8
$F_{Mq,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.1	1.1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1.1	1.1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	1
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2	2	1
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	98	98	48

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-93 Specific-to-Farm Factors, Southern Texas Cow Calf 200

Parameter	Description	Unit	Improved pasture	Hay	Cow-calf
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725	1.725	1.725
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0966	0.097	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361	361	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441	441	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841	841	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.10	0.10	0.10
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.48	0.48	0.48
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.35	0.35	0.35
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.05	0.05	0.05
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00	0.00	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	37	37	37
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	37	37	37
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.1	1.1	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1.1	1.1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	1
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 head^{-1} year^{-1}	2	2	2
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 head^{-1} year^{-1}	98	98	78

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-94 Specific-to-Farm Factors, Texas Rolling Plains Cow-calf 500

Parameter	Description	Unit	Cow-calf
$Price_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.725
$Price_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0966
$fertPrice_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	361
$fertPrice_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	441
$fertPrice_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	841
$herbPrice_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8
$inscPrice_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5
$Prop_{NF}$[b]	proportion of electricity from nuclear fission	index	0.10
$Prop_{NG}$[b]	proportion of electricity from natural gas	index	0.48
$Prop_{CL}$[b]	proportion of electricity from coal	index	0.35
$Prop_{WB}$[b]	proportion of electricity from woody biomass	index	0.00
$Prop_{HB}$[b]	proportion of electricity from herbaceous biomass	index	0.00
$Prop_{WND}$[b]	proportion of electricity from with wind	index	0.05
$Prop_{HE}$[b]	proportion of electricity from hydroelectric dams	index	0.00
$SOC_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	37
$SOC_{Ref,Z,0-t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	37
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8
$F_{Lu,Z,0-t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1
$F_{Mg,Z,0-t}$[c]	SOC scaling factor- tillage practices at the end of the period	index	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	1
$F_{O,Z,0-t}$[c]	SOC scaling factor-residues at end of the period	index	1
$EF_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	2
$EF_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 $head^{-1}$ $year^{-1}$	65

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

Table B-95 Specific-to-Farm Factors, Moderate Iowa Feedgrain

Parameter	Description	Unit	Alfalfa hay	Meadow hay	Oats/alfalfa	Cow-calf
$\text{Price}_{diesel,2009}$[a]	price of diesel in 2009	U.S. dollars gal^{-1}	1.628	1.628	1.628	1.628
$\text{Price}_{electricity,2009}$[b]	price of electricity in 2009	U.S. dollars kwh^{-1}	0.0728	0.0728	0.0728	0.0728
$\text{fertPrice}_{Ammonium\ Nitrate,2009}$[a]	price of NH_4NO_3 in 2009	U.S. dollars ton^{-1}	458	458	458	458
$\text{fertPrice}_{Phosphoric\ Acid,2009}$[a]	price of P_2O_5 in 2009	U.S. dollars ton^{-1}	1100	1100	1100	1100
$\text{fertPrice}_{Potash,2009}$[a]	price of K_2O in 2009	U.S. dollars ton^{-1}	893	893	893	893
$\text{herbPrice}_{atrazine,2009}$[a]	price of atrazine in 2009	U.S. dollars gal^{-1}	20.8	20.8	20.8	20.8
$\text{inscPrice}_{synthetic\ pyrethroid,2009}$[a]	price of synthetic pyrethroids in 2009	U.S. dollars gal^{-1}	98.5	98.5	98.5	98.5
Prop_{NF}[b]	proportion of electricity from nuclear fission	index	0.00	0.00	0.00	0.00
Prop_{NG}[b]	proportion of electricity from natural gas	index	0.01	0.01	0.01	0.01
Prop_{CL}[b]	proportion of electricity from coal	index	0.91	0.91	0.91	0.91
Prop_{WB}[b]	proportion of electricity from woody biomass	index	0.00	0.00	0.00	0.00
Prop_{HB}[b]	proportion of electricity from herbaceous biomass	index	0.00	0.00	0.00	0.00
Prop_{WND}[b]	proportion of electricity from with wind	index	0.05	0.05	0.05	0.05
Prop_{HE}[b]	proportion of electricity from hydroelectric dams	index	0.02	0.02	0.02	0.02
$\text{SOC}_{Ref,Z,0}$[c]	reference value of soil organic C at beginning of study period	tonnes C ha^{-1}	42	42	42	42
$\text{SOC}_{Ref,Z,0\text{-}t}$[c]	reference value of soil organic C at end of study period	tonnes C ha^{-1}	42	42	42	42
$F_{Lu,Z,0}$[c]	SOC scaling factor-land use at beginning of the study period	index	0.8	0.8	0.8	0.8
$F_{Lu,Z,0\text{-}t}$[c]	SOC scaling factor- land use at end of the study period	index	0.8	0.8	0.8	0.8
$F_{Mg,Z,0}$[c]	SOC scaling factor-tillage practices at the beginning of the period	index	1.1	1.1	1.1	1
$F_{\text{Mg},Z,0\text{-}t}$[c]	SOC scaling factor-tillage practices at the end of the period	index	1.1	1.1	1.1	1
$F_{O,Z,0}$[c]	SOC scaling factor-residues at beginning of the period	index	0.94	0.94	0.94	1
$F_{O,Z,0\text{-}t}$[c]	SOC scaling factor-residues at end of the period	index	0.94	0.94	0.94	1
$\text{EF}_{manure,ND,\tau}$[d]	CH_4 emission factor-non dairy cattle manure	kg CH_4 head^{-1} year^{-1}	2	2	2	1
$\text{EF}_{manure,D,\tau}$[d]	CH_4 emission factor-dairy cattle manure	kg CH_4 head^{-1} year^{-1}	98	98	98	48

[a]Factors are from USDA (2010). [b]Factors are from DOE (2010). [c]Factors are from EPA (2011). [d]Factors are from Eggleston et al. (2006).

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